Biological Evaluation
Invasive Species Management Project
Regional Forester Sensitive Species (RFSS) and Species of Viability Concern (SVC)
Shawnee National Forest, Illinois

(Alexander, Gallatin, Hardin, Jackson, Johnson, Massac, Pope, Saline and Union Counties)

Note: References used in the completion of this document can be found in the Invasive Species Management Project File located in the Supervisor's Office of the Shawnee National Forest, 50 Highway 145 South, Harrisburg, Illinois, 62946. This Biological Evaluation (BE) includes effects determinations for Regional Forester designated animal species for the Shawnee National Forest (Forest) and effects on Forest animal species with viability concerns (SNF Plan 2006, Appendix H). These site specific effects are determined, in part, using information located in 1) the Programmatic Biological Opinion for the Shawnee National Forest Plan (BO) signed by the U.S. Fish and Wildlife Service (FWS) on December 13, 2005; 2) the Shawnee National Forest Programmatic Biological Assessment for the Forest Plan Revision (BA) dated September 6, 2005; and 3) Chapter 3 of the Final Environmental Impact Statement for the 2006 Forest Plan.

Introduction

The purpose of this BE is to identify the likely effects of the proposed actions and alternatives in the Invasive Species Management Project to forty RFSS animals and nine animal species of concern for the Forest. The BE is completed to ensure that Forest Service actions (1) do not contribute to a loss of viability or trend toward federal listing of any species and (2) provide a process and standard that ensure the above animal species receive full consideration in the decision making process.

Purpose of and Need for Action

The purpose of this project is to protect and restore naturally-functioning native ecosystems on the Shawnee National Forest by controlling or eliminating populations of non-native invasive plant species. Forest-wide action is needed at this time because:

- invasive species are increasingly degrading native plant communities and jeopardizing the survival of some local native plant communities;
- established invasive species populations serve as a seed source for spreading infestations,
- taking action now averts creation of a more widespread and costly future problem
- existing invasive species populations have the potential to spread to adjacent lands and facilitate the spread of invasive species in Illinois
- Past control efforts, (focused on small areas using mostly manual methods) were only marginally successful in arresting the establishment of invasive species populations;
- invasive species populations persist and continue to spread, evidencing a need for a comprehensive and integrated approach to treatment; and
- preventing new infestations from becoming established is more effective than trying to control and eradicate entrenched infestations.

Action is needed to effectuate the guidance in the Forest's 2006 Land and Resource Management Plan (Forest Plan, p 47), which states: *The risk and damage from existing non-native invasive species should be reduced through integrated pest management. Invasion prevention measures should be implemented to maintain native ecosystems. Existing populations of non-native invasive species should be eradicated, controlled and/or reduced. Effects of management activities on the invasion and spread of non-native invasive species should be considered and mitigated, if needed. Natural areas and lands adjacent to natural areas have the highest priority for the prevention and control of non-native invasive species.*

Proposed Action

The Forest Service proposes to take a dual approach to the control of invasive species:

1. **Forest-wide treatment with prescribed fire and manual, mechanical and/or chemical control methods of all known sites of the four highly invasive species: Amur honeysuckle, Chinese yam, garlic mustard and kudzu.**
2. **Management of 23 natural areas and their treatment zones, including control of invasive species, through the use of prescribed fire and manual, mechanical and/or chemical control methods.**

The proposed action would integrate various control methods—manual, mechanical and chemical—to eliminate or control invasive species populations. The proposed action generally would target aggressive invasive species, but also would manage specified native plants threatening unique ecosystems or degrading natural-area community integrity. This work would be accomplished over the next ten years, with periodic reviews of the assumptions, data and analysis on which the responsible official will base his decision

Existing Condition

The Project may be implemented anywhere across the Forest where invasive plant infestations are identified in the environmental assessment. Many of these infestations are documented along roadsides, within recreation sites, within food plots, along riparian areas, in newly acquired or exchanged lands, and in some natural areas. Field survey and inventory of invasive species has been occurring in natural areas on the Forest for over 20 years and locations of invasive species plants on the Forest have been recorded for decades. In 2004, the Forest entered into a cooperative agreement with Southern Illinois University to develop a systematic database of existing inventory records of invasive species sites on the Forest. Surveys have generally been focused along road and trail corridors, areas with rare plants species, unique habitats and areas that have or will experience ground disturbance. Over 1500 infestation sites of invasive species infestation involving 80 different invasive species have been identified. Database management is an ongoing job and for this analysis of existing inventory information, as of January 20, 2009 was used. This database is the best available information regarding the type and extent of invasive species infestation on the Forest.

The ecological settings on the Forest are described in detail in chapter 3 of the Final Environmental Impact Statement (FEIS) for the Forest Plan (2006). Habitats on the Forest are diversified. The Forest encompasses about 286 thousand acres of the State of Illinois in the nine southern-most counties. National Forest System land makes up about 1/3 of the land ownership within its proclamation boundaries and purchase units. Most of the Forest is within three physiographic provinces, including extensions of the Ozark Plateau, Interior Low Plateaus, and Gulf Coastal Plain. These regions include extraordinary geological, hydrological and ecological diversity. The Forest and the project area are bounded by the Mississippi River on the west and the Ohio River on the east and are unglaciated. Signature features of the Forest include broad floodplains of the large rivers, large cuestas of the greater Shawnee hills, karst areas of the lesser Shawnee Hills, Ozark Hills, and Cretaceous Hills and some of the highest quality streams remaining in Illinois. The Forest is predominantly upland hardwood forest dominated by oak/hickory forests with some smaller amounts of bottomland, hardwood forests in floodplains of rivers and streams, and very small areas of grasslands and barrens the latter mostly on the eastern parts of the Forest.

Description of Alternatives

Common to All Alternatives: Prevention and Education

Prevention and education are important elements of our overall invasive species management strategy (project record). Prevention of the spread of invasive species is recognized as a primary part of the mission of the Forest Service (USDA Forest Service 2003) and the Forest is implementing prevention measures currently, including the washing of equipment before and after entry onto Forest lands, ensuring the revegetation of treated invasive species sites, the placement of hiker boot-brush stations, and education.

Our invasive species prevention and education program includes our participation in the River-to-River Cooperative Weed Management Area (CWMA) partnership. This is a group effort of 12 federal and state agencies, organizations and universities whose goal is the coordination of efforts and programs for addressing the threat of invasive plants in southern Illinois. The CWMA was established in 2006 and addresses invasive plant species through collaborative projects and activities focused on education and public awareness, early detection and rapid response, prevention, control and management, and research.

Alternative 1 – No Action

Under this alternative, we would continue to implement our current strategies of invasive species management: Pulling and torching about 100 to 150 acres of invasive species annually, inventorying and mapping infestations, and burning about 6,000 acres per year to set back invasive species, including in some designated natural areas. We will continue to apply herbicides in campgrounds and at administrative sites (about 50-100 acres per year), contributing to invasive species control in those areas. No ground-disturbing mechanical treatments could be done, nor could herbicide be applied outside of administrative sites and campgrounds.

Alternative 2 – Proposed Action

Under this alternative, we would treat invasive plant infestations using an integrated combination of prescribed fire and manual, mechanical and/or chemical methods. We would continue to use public information and education to increase awareness of invasive species issues. We would treat specified Forest lands (see maps), given available time and resources. Post-treatment monitoring would evaluate effectiveness and success, which we would disclose in our annual monitoring reports. The Forest Service proposes to take a dual approach to the control of invasive species:

1. Treatment Forest-wide of all known sites with four highly invasive species: The project interdisciplinary team reviewed the many invasive species on the Forest and identified four as priorities to be targeted across the Forest: Amur honeysuckle *(Lonicera maackii*), on about 650 acres at about 40 sites, Chinese yam (*Dioscorea oppositifolia*), on about 340 acres at about 45 sites, garlic mustard (*Alliaria petiolata*), on about 500 acres on about 70 sites, and kudzu (*Pueraria montana*), on about 15 acres at 6 sites (see maps for locations). For the most part, these species were chosen because of their high degree of invasiveness and/or their ability to suppress or extirpate native vegetation and wildlife by their aggressive growth characteristics. Published science, monitoring, and field study indicate that active management of these species can greatly reduce both their current and potential adverse effects on native plants and animals with minimal impact on the surrounding environment. An integrated treatment approach using manual and mechanical methods and, where appropriate, herbicide is proposed to control and eliminate the four highly invasive species where they occur.

Table 1. High-Priority Natural Areas.*	
Ava Zoological Area	Keeling Hill South Ecological Area
Barker Bluff Ecological Area / Research Natural Area	Kickasola Cemetery Ecological Area
Bell Smith Springs Ecological Area	LaRue Pine Hills–Otter Pond Ecological Area / Research Natural Area
Bulge Hole Ecological Area	Massac Tower Springs Ecological Area
Cretaceous Hills Ecological Area	Odum Tract Ecological Area
Dean Cemetery West Ecological Area	Panther Hollow Botanical Area / Research Natural Area
Double Branch Hole Ecological Area	Poco Cemetery East Ecological Area
Fink Sandstone Barrens Ecological Area	Poco Cemetery North Ecological Area
Fountain Bluff Geological Area	Reid's Chapel Ecological Area
Hayes Creek-Fox Den Ecological Area	Russell Cemetery Barrens Ecological Area
Jackson Hole Ecological Area	Snow Springs Ecological Area
Keeling Hill North Ecological Area	

To some, kudzu does not fit the "highly invasive" description in Illinois. However, we are targeting this species because the State of Illinois has an aggressive kudzu eradication program and, as a partner of the state in this effort, we are including it as a priority species in this proposal. Garlic mustard is very invasive and has allelopathic properties that suppress native vegetation and change soil properties to favor itself.

This species would be the highest priority for treatment. Kudzu, Chinese yam and Amur honeysuckle would follow in order of priority.

2. Management of 23 designated natural areas and their treatment zones:

The interdisciplinary team reviewed the information on invasive species in natural areas and identified those most threatened with vigorous infestations or with the most vulnerable natural communities. Based on these factors, the team selected 23 high-priority natural areas for analysis (Table 1). To enable maximum protection of the selected natural areas, the team configured "treatment zones"—along streams, roads and trails, the main pathways of invasive species infestation—adjacent to and generally upstream of the areas. As detailed in Table 3 and Appendix A, we would target all invasive species in the natural areas and their treatment zones, following the published guidance of the Illinois Nature Preserves Commission (INPC 1990**).**

Management would include the application of prescribed fire in the natural areas and their treatment zones, about 11,220 acres. Existing fire-breaks, such as roads, trails, streams and other natural features, would be used as firelines where possible; but mechanically constructed firelines would be used where necessary. We expect to install about 14 miles of lines by hand, using leaf-blowers that cause no earth-disturbance, and 6 miles mechanically, which would be earth-disturbing. These lines would be restored promptly in accordance with the Forest Plan guidelines in Appendix F and Illinois Forestry Best Management Practices (see Table 5).

The treatment zones would be burned at intervals of 1-3 years, depending on fuel availability and the monitoring and assessment of effects to determine the need for additional fire. The fire would help restore native vegetation and set back the progression of invasive species. Further burns would be done as needed to maintain the areas' ecological integrity once invasive vegetation has been suppressed.

Herbicides could be applied to control invasive species either before or after the burns, in about 675 acres of the treatment zones, depending on the species present (see Table 3 and Appendix A). Some species, such as grasses, grow well in response to fire and would be targeted before the burns or following, when new growth appears. Other species, such as Japanese honeysuckle and multiflora rose, are generally set back by fire, so burning them off before applying herbicides would limit the amount of herbicide required for control or eradication. We would apply herbicides as needed until infestations are controlled or eliminated.

The proposal includes thin-line application, basal-bark treatment and "hack-and-squirt" (cutting into a tree's cambium and applying herbicide), as well as the cutting and stump-spraying and/or girdling of some native trees and shrubs on about 275 acres of barrens, glades and seep-springs to improve growing conditions for the natural communities. Barrens and glades are unique native plant communities that traditionally have sparse vegetation. With the exclusion of fire, some of these areas have grown up in shrubs and trees that shade out native and sensitive plant species, limiting the diversity of the plant community. Thinning the barrens and glades helps to restore their naturally dry condition and the species adapted to it. Similarly, we would control the trees and shrubs that are encroaching on seep-spring areas and de-watering their rare plant communities.

The high-priority natural areas for prescribed fire and herbicide treatment are those with acid seep-springs: Cretaceous Hills, Dean Cemetery West, Kickasola Cemetery, Massac Tower Springs and Snow Springs. These are the most threatened by invasive species and changes. The encroachment of aggressive invasive species into these areas threatens to dry up the springs and dramatically degrade the plant community, destroying the spring habitat. Rare plant resources rely on this habitat type, including Regional Forester Sensitive Species, such as twining screwstem (*Bartonia paniculata*), purple five-leaf orchid (*Isotria verticillata*), longbeak arrowhead (*Sagittaria australis*) and New York fern (*Thelypteris noveboracensis*). Additional plant species of this community-type, including several listed as threatened or endangered by the State of Illinois, are also vulnerable to local extirpation without immediate management.

Of the remaining 18 natural areas, 11 have Regional Forester Sensitive Species and numerous other rare plant resources: Double Branch Hole, LaRue-Pine Hills, Poco Cemetery East, Poco Cemetery North, Bulge Hole, Fink Sandstone Barrens, Bell Smith Springs, Hayes Creek-Fox Den, Panther Hollow, Jackson Hole and Barker

Bluff. Streams run through, or are adjacent to, all these areas, providing a corridor for invasive plant species, especially Nepalese browntop. These areas would be the second priority for invasives treatments.

The remaining seven natural areas, Fountain Bluff, Ava, Keeling Hill North, Keeling Hill South, Odum Tract, Russell Cemetery and Reid's Chapel, contain dry to dry-mesic barren-communities, which provide a unique assemblage of rare plant resources. These areas would be our third priority for treatment. The other 57 natural areas also contain invasive species; however, in order for us to systematically control and eradicate invasives, it is imperative that we prioritize the natural areas that require immediate attention to preserve their integrity.

Herbicide Treatments

We have analyzed the treatment of about 2,500 acres of invasive species infestation across the Forest annually (see totals at Appendix A). We would limit our chemical treatment of invasive species to five herbicides: triclopyr, clopyralid, glyphosate, sethoxydim and picloram (Table 2). We selected the herbicides in consultation with the IDNR and the CWMA, both of which have extensive experience with these specific herbicides. With the exception of picloram, which we propose to apply only to the cut stumps of kudzu in limited quantity and locations, each of the herbicides is the least toxic, least persistent chemical available to meet our purpose and need. We followed published guidance of the Illinois Nature Preserves Commission (INPC 1990) and The Nature Conservancy (TNC 2004) in selecting these commonly used, generally low-impact herbicides that should provide effective treatment. Additionally, we propose to use the most controllable application methods that would have the least residual impact:

1) a hand-held applicator, hack-and-squirt, sprayer, brush or wick applicator
2) backpack sprayer
3) boom-mounted spray rig (on an all-terrain or utility vehicle, pickup truck, or tractor)

We do not propose aerial applications.

As specified in the Design Criteria in Table 5, we would apply herbicides at or below label-recommended rates, using only those registered by the EPA for the specific type of site and use we propose. We would follow all applicable state and federal laws. We would apply herbicides according to label directions and, within the natural area treatment zones, in accordance with the guidance published by the Illinois Nature Preserves Commission and The Nature Conservancy and monitor our use in compliance with best management practices and direction in the Forest Service Manual (2080, 2150 and 2200). We would prepare a Pesticide Use Proposal (FS-2100-2) and safety plan (FS-6700-7) prior to any herbicide use. We would post signs to alert the public to the location and types of treatments being done and the date when a treated area could be re-entered.

We would apply herbicides during the time of year when application is most effective for a particular species and its life-cycle. (See Table 3 for Illinois Nature Preserves Commission's recommendations.) If a first application of an herbicide should not be as effective as expected, we would re-treat with one of the proposed herbicides to ensure complete removal or control. We would ensure the re-establishment of native vegetation on a treated site through monitoring after removal of the invasive species and reseeding and/or planting native species if necessary to repopulate the site.

Control techniques could vary depending on the size or location of the infestation (see details in Table 3). We developed our proposed methods after review of the guidance published by the Illinois Nature Preserves Commission and The Nature Conservancy, scientific literature, the field experiences of Forest botanists and wildlife biologists, and discussions with invasive species experts.

Table 2. Proposed Chemical Controls in Alternative 2.

Chemical Name	Examples of Trade Names	Targeted Use	Examples of invasive plants to be targeted	Risk Assessment
Clopyralid	Curtail™ Reclaim™ Transline™	Foliar spray; broadleaf selective–especially legumes, smartweeds and composites	kudzu, lespedeza, oxeye daisy, crownvetch	Durkin 2004a
Glyphosate	Accord® Foresters®	Woody and broadleaf plants: stump treatment, 10-20% solution; foliar spray; non-selective;	Amur honeysuckle, autumn olive, Japanese honeysuckle, garlic mustard, multiflora rose	Durkin 2011a
Glyphosate (aquatic)	Aquamaster® Rodeo®	Foliar treatment, invasives near open water, non-selective	purple loosestrife, common reed, any species near open water	Durkin 2011a
Picloram	Tordon K Tordon 22k; Grazon	Stump and/or basal-bark treatment	kudzu	Durkin 2011b
Sethoxydim	Poast® Vantage®	Foliar spray; narrowleaf selective (grasses)	Nepalese browntop, Canada bluegrass, bald brome	Durkin 2001
Triclopyr	Crossbow™ Garlon™3A Garlon™4 Habitat®; Pasturegard™ Vine-X®	Stump and/or basal-bark treatment, foliar spot spray; broadleaf selective; woody plants	Chinese yam, kudzu, Amur honeysuckle, autumn olive, lespedeza, clover, Japanese honeysuckle	Durkin 2011c
				(http://www.fs.fed.us/foresthealth/pesticide/risk.shtml)

Alternative 3 – Treatment Action without Synthetic Herbicides

Under this alternative, no synthetic herbicides would be used to control invasive species. The methods we propose rely on aggressive manual or mechanical treatments as the first course of control. Natural weed-killers could be applied where manual and mechanical methods are ineffective. This alternative was developed in response to public concerns about the unintended consequences of the use of synthetic herbicides. It is designed to control some invasive species, but would not eradicate many populations because the natural weed-killers only top-kill the plants.

1. Forest-wide treatment of four highly invasive species:

Under this alternative we would concentrate on the same four highly invasive species as under the proposed action, but would use manual and mechanical methods as a first line of treatment (Table 4). Kudzu sites would be treated initially with prescribed fire, with a backhoe or bulldozer used to remove individual plants, concentrating on the root crowns. Amur honeysuckle and garlic mustard sites would be removed by concentrating on individual plants. Amur honeysuckle would be pulled or grubbed out. Garlic mustard would be hand-pulled or torched. Chinese yam would be treated initially by continual mowing, clipping or torching. For all four species, natural herbicides could be applied after initial work has reduced the vigor of populations.

Natural herbicides are simple substances that directly top-kill plants upon application. These substances are encountered naturally, but in small quantities. Food-grade vinegar and clove oil are the main active ingredients in one type of natural herbicide. However, the concentrations used in the natural weed-killers are higher than available at a grocery store. Vinegar at the grocery store is usually 5 percent acetic acid, while the natural weed-killer contains a 20-percent solution. These ingredients are relatively well known and normally not harmful to humans or animals. However, when applied in large doses, the results are usually obvious in a very short time. After treatment, their damaging effect is quickly dissipated. Vinegar is acetic acid along with other weak organic acids. Clove oil is an essential oil from the clove plant (*Syzygium*

aromaticum). This mixture works by disrupting plant membranes and causing the leakage of cells. The damage to plants appears rapidly, in 1-2 days.

A hot-foam machine could be used from roads and some trails to steam-kill invasive species. The Waipuna® hot-foam system, for example, is comprised primarily of a diesel-powered boiler and foam generator that deliver hot water with a foam surfactant to target weeds via a supply hose and a treatment wand. The superheated hot foam (sugar is added to achieve a higher boiling point than water) is applied to the targeted vegetation at a high temperature (200°F) and low pressure; the foam traps the steam, giving it time to "cook," or "blanch," the vegetation. This causes a cellular collapse of the treated aboveground vegetation. This control method is limited in mobility and is best used near developed sites such as campgrounds and trailheads and along roadsides and accessible trails.

Table 3. Proposed Treatment Methods under Alternative 3.

National Forest Lands		
Species	Methods*	Approximate Acres
Garlic mustard	Pulling, Torching	800
Kudzu	Prescribed Burn, Bulldozer/Back Hoe **	75
Bush honeysuckle	Cutting, Pulling, Torching	1600
Chinese yam	Repeated Clipping, Torching,	750
Subtotal		3225
23 Priority Natural Areas and Treatment Zones		
Example Species	Methods	Approximate Acres
Nepalese browntop	Pulling, Weed-Whipping	1150
Sweetclover	Burning, Cutting, Pulling	25
Autumn olive	Cutting, Grubbing	1275
Multiflora rose	Cutting, Grubbing	775
Tall fescue	Tilling, Smothering	500
Sericea lespedeza	Pulling, Weed-Whipping, Cutting	130
Japanese knotweed	Grubbing, Pulling	8
Japanese honeysuckle	Torching, Cutting, Grubbing	1400
Princesstree	Grubbing, Cutting	2
Crownvetch	Pulling, Grubbing	5
Asiatic dayflower	Pulling, Grubbing	3
Common sheep sorrel	Pulling, Grubbing	10
Common periwinkle	Pulling, Grubbing	2
Tree of heaven	Pulling, Grubbing, Cutting	10
Beefsteak plant	Pulling, Grubbing	35
Shortleaf pine	Cutting, Pulling	255
Queen-Anne's lace	Pulling	25
Subtotal		5610
Total		8835
Methods	Pulling, Cutting, Grubbing	7510
	Bulldozer / Backhoe	75
	Tilling, Smothering, Clipping, Torching	1250

***** Natural weed-killer could be used for all species.
****** Only non-motorized would be used within wilderness.

2. Management of 23 designated natural areas and their treatment zones:

All invasive species within the specified natural areas (Table 1) would be treated using the methods outlined in Table 4. Management would include the application of prescribed fire in the natural areas and the pathways of invasion—stream corridors and roads and trails (treatment zones), about 15,000 acres. Existing fire-breaks, such as roads, trails, streams and other natural features, would be used as firelines where possible; but mechanically constructed firelines would be used where necessary. We expect to install about 14 miles of lines by hand and 6 miles mechanically.

The treatment zones would be burned at intervals of 1-3 years, depending on fuel availability and the assessment of effects to determine the need for additional fire. The fire would help restore native vegetation and set back the development of invasive species. Further burns would be done as needed to maintain the areas' ecological integrity once invasive vegetation has been suppressed. Manual and mechanical weed-treatment methods would be applied to manage invasive species either before or after the initial burns, depending on the species present.
The highest priority natural areas for prescribed fire and natural herbicide treatment would be those with acid seep-springs: Cretaceous Hills, Dean Cemetery West, Kickasola Cemetery, Massac Tower Springs and Snow Springs. These are the most threatened by invasive species and changes. The encroachment of aggressive invasive species into these areas threatens to dry up the springs and dramatically degrade the plant community, destroying the spring habitat. Rare plant resources rely on this habitat type, including Regional Forester's Sensitive Species, such as twining screwstem (*Bartonia paniculata*), purple five-leaf orchid (*Isotria verticillata*), longbeak arrowhead (*Sagittaria australis*) and New York fern (*Thelypteris noveboracensis*). Additional plant species of this community-type, including several listed as threatened or endangered by the State of Illinois, are also vulnerable to local extirpation without immediate management.

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Key Issues and Indicators

We separated the issues into two groups: key and non-key issues. Key issues are those directly or indirectly caused by implementing the proposed action or alternatives. A list of non-key issues and reasons why they were determined to be non-key may be found in the project record. Issues are points of debate, disagreement or dispute about the environmental effects of a proposed action. The interdisciplinary team identified the potential issues related to the invasive species control project and this list of issues was reviewed and approved by the responsible official. The following is the list of key issues:

Key Issues and Indicators

- The establishment and growth of invasive species may affect natural areas and ecosystems, including plants and wildlife.
    - Plant Community Indicator: The response of the plant community to the proposed action will be discussed in terms of acres of invasive species reduced and native species restored.
    - Wildlife Community Indicator: The response of the wildlife community to the proposed action will be discussed in terms of potential changes in the habitat (density and diversity of understory vegetation) on ground nesting birds.
- The application of prescribed fire may affect natural areas and ecosystems, including soil, water, plants and wildlife.
    - Soil & Water Quality Indicator: The amount of soil erosion (tons/acre/year).
    - Plant Community Indicator: The response of the plant community to the proposed action will be discussed in terms of changes in the number and frequency of invasive and native plant species.

    - Wildlife Community Indicator: The response of the wildlife community to the proposed action will be discussed in terms of potential changes in the habitat (density of undisturbed leaf litter, coarse woody debris and density and diversity of understory vegetation) of ground nesting birds.
- The application of herbicides may affect natural areas and ecosystems, including soil, water, plants and wildlife.
    - Soil & Water Quality Indicator: Pounds of active ingredient of herbicide used.
    - Plant Community Indicator: The response of the plant community to the proposed action will be discussed in terms of the effect on the natural area's significant and exceptional features for which they were designated.
    - Wildlife Community Indicator: The response of the wildlife community to the proposed action will be discussed in terms of potential changes in the habitat of management indicator species.
- The application of herbicides may affect humans.
    - Human Health Indicator: The response of general populace to the proposed action will be discussed in terms of the effect that the properly approved and applied chemical eradication measures will have on public health and employees/applicators.

2006 Forest Plan Standards and Guidelines

The Invasive Plant Species Management Project incorporates the Standards and Guidelines of the 2006 Forest Plan. These were consistent with the Plan BO. Forest-Wide Standards and Guidelines can be found in Chapters 2 and Appendix H of the 2006 Forest Plan and were incorporated into this project during proposal development. Standards are mandatory, whereas guidelines should be followed in most circumstances.

Forest-wide and management area specific standards and guidelines are incorporated into each alternative. The implementation of these standards and guidelines will result in the continued maintenance of populations of all (40) RFSS and (9) SVC animal species on the Forest. Some of these small populations may not be large enough to be fully viable and self-sustaining populations on the Forest because of the overall rarity of habitats for the species on the Forest and/or rarity of the species itself for reasons beyond the control of the Forest. They would however contribute to maintaining viable populations over larger geographical scales and the genetic diversity of individual species.

Design Criteria Action Alternatives

In order to minimize impacts on the environment and habitats from invasive species management, we would apply several design criteria under both action alternatives (Tables 5 and 6). These criteria are based on requirements of Forest Service regulations, the Forest Plan, IDNR Forestry Best Management Practices and herbicide label directions. They are part of the design of the project rather than mitigations developed as responses to concerns or ongoing effects. All treatment locations will be recorded with global positioning systems and tracked in a database to plan out-year program needs.

Table 4. Design Criteria for Invasive Species Management.

Resource Area	Design Criteria	Rationale / Effectiveness
Invasive Plant Species	Clean all equipment before entering and leaving project sites.	Minimizes spread of noxious weeds from one site to the next (USDA-FS 2004). Guide to Noxious Weed Prevention Practices (2001).
	Workers should inspect, remove and properly dispose of plant parts and seeds found on clothing and equipment before entering or leaving the project area.	
	Minimize soil disturbance to avoid creating favorable conditions that encourage weed establishment.	
Botanical Resources	Ensure that rare plant resources are protected from mechanical or chemical treatments.	Rare plant resources will be protected and habitat enhanced.
	State of Illinois threatened and endangered species will be protected from mechanical or chemical treatments.	At the request of INDR, known locations of state-listed plant species will be avoided.

Table 4. Design Criteria for Invasive Species Management.		
Resource Area	**Design Criteria**	**Rationale / Effectiveness**
Wildlife Resources	Retain all standing dead trees unless necessary to cut for human safety or to accomplish project objectives. Suitable Indiana bat summer roost trees cannot be removed April 1 - Sept. 30.	These design criteria are required "terms and conditions" or "reasonable and prudent measures" in US Fish and Wildlife Service Biological Opinion for the Forest Plan (Forest Plan, Appendix H, C.1.b. and C.1.c.).
	To reduce the chances of affecting maternity roosts and foraging habitats, no prescribed burns shall be done in upland forests from May 1 - Sept. 1.	
	Burning near known timber rattlesnake den locations will be done only during hibernation seasons when individuals are in dens (11/1-3/31).	Den sites are extremely important to the maintenance of populations (Forest Plan, FW51.1.2.3, FW51.1.2.4, FW51.1.2.5).
	For protection of the nests and nestlings of migratory birds, burns should be done as early or late in the season as possible, preferably before 4/1 and after 8/1.	For the protection migratory birds (Forest Plan, FW51.1.2.6.
	In order to protect eastern small-footed bats, rock outcroppings and cave entrances in the project area will not be intentionally ignited by burn crews. No firelines would be constructed in or immediately adjacent to cave habitat.	These habitats require additional protection identified in the Forest Plan (USDA 2006).
	Prescribed fire should not be applied to known locations of the carinate pill snail in LaRue-Pine Hills Research Natural Area.	This is protection suggested in the conservation assessment for the carinate pill snail (Anderson 2005).
Heritage Resources	The area of potential effects will be inventoried to ensure that all heritage resources are adequately protected from project-related impacts.	Project monitoring from 1991-2005 indicates few sites have been missed using our inventory methods (McCorvie: A Decade of Monitoring).
Recreation & Visual-Resource Management	Ensure visitor safety before, during and after burning activities. Burn areas should be closed to the public.	Forest Plan, Chap. I, B; FW23.2 & FW23.3
	Protect existing recreational improvements, such as campgrounds, trailheads and trail-signing and other amenities.	Forest Plan, FW23.2
	Damage to existing trails and roads used as firebreaks or for access should be repaired to standard.	Forest Plan, Chap. FW23.3
Wilderness Resources	Ensure non-motorized herbicide applications are utilized.	Wilderness Act of 1964, Forest Plan WD19.3
Soil and Water Resources	Use erosion-control measures for firelines that could erode soil into lakes, streams and wetlands.	Illinois Forestry Best Management Practices are designed to ensure that prescribed fire does not degrade the forested site and that waters associated with these forests are of the highest quality (IDNR et al. 2000). We have monitored the effectiveness of mitigation measures on several past prescribed fire projects and found that the measures were effective in minimizing soil erosion and subsequent sedimentation in streams. Specific guidelines can be found in the Illinois Forestry Best Management Practices, Chapter 7, Prescribed Burning.
	Avoid intense burns that remove forest-floor litter and so could expose excessive bare soil that may erode into surface water.	
	Where possible, locate bladed firelines on the contour. Construct water-bars as needed to direct surface water from firelines and into undisturbed forest cover.	
	Maintain soil-stabilization practices until the site is fully revegetated and stabilized.	
	Avoid operating heavy equipment in a manner that causes excessive soil displacement, rutting, or compaction.	
	Guidelines for protection of water quality; standards for protection of soil and water in riparian corridors and riparian areas; guidelines for the reduction of bare-soil disturbance and exposure in riparian corridors; standards for restoration of disturbed-soil areas; standards for the limitation and use of heavy equipment, and standards for soil-disturbance limitations.	Implementation of the protection measures and management recommendations at Forest Plan FW25 will prevent excessive sedimentation.
	Retain native vegetation and limit soil disturbance as much as possible.	Adherence to Forest Plan direction and Illinois
	Revegetate soils disturbed by management activities by allowing growth of existing on-site vegetation where	

Table 4. Design Criteria for Invasive Species Management.		
Resource Area	**Design Criteria**	**Rationale / Effectiveness**
	possible and desirable.	Department of Resources Best Management Practices regarding protection of aquatic habitats will prevent damage to these areas.
	Fueling or oiling mechanical equipment must be done away from aquatic habitats.	
	Only herbicide formulations approved for aquatic use shall be applied in or adjacent to aquatic systems, following label directions.	
	When using pesticides in riparian areas and within 100 feet of sinkholes, springs, wetlands and cave openings, adhere to the following: Minimize the use of pesticides, herbicides; use only pesticides labeled for use in or near aquatic systems; and use only herbicides based on environmental analysis that shows they are environmentally sound and the most biologically effective method practicable.	
	No triclopyr (ester formulation) or surfactants used with glyphosate (terrestrial version) will be applied within the riparian area or within 100 feet of lakes, ponds, sinkholes or wetlands.	Compliance with herbicide label directions will prevent misuse of chemicals used for treatment of invasive species.
	In areas with soil disturbance, erosion controls will be implemented to prevent soil loss or habitat degradation as needed.	
	Forest staff will consider prevailing weather conditions and use lower volatility formulations under conditions that might result in a high risk of volatilization.	

1. WILDLIFE RESOURCES

Project and Cumulative Effects Background

Significant portions of the Forest, including natural areas, openlands and timber stands, have been surveyed many times by Forest wildlife biologists and botanists, IDNR Heritage Staff, numerous researchers from Southern Illinois University and Ball State University (Indiana) over the last 30 years, and especially since the early 1970's.

The "Endangered and Threatened species of Illinois: Status and Distribution, Volume I - Plants," "Endangered and Threatened species of Illinois: Status and Distribution, Volume II - Animals," "Additions, deletions and changes to the Illinois list of Threatened and Endangered species," "2011 USDA Forest Service Eastern Region Regional Forester's Sensitive Species List," "1999 Checklist of endangered and threatened animals and plants of Illinois," and Illinois Department of Natural Resource's "Biological Conservation Database (March 2001)" were reviewed for current listings, habitat, and known location information. Public scoping on this project was also conducted. Species distribution records and site specific field surveys indicate the forty (40) Regional Forester Sensitive (RFSS) and nine (9) Species with Viability Concern (SVC) are being evaluated in this BE (Tables 6 and 7).

The Forest is located in the southern tip of Illinois. Land ownership includes portions of Alexander, Gallatin, Hardin, Jackson, Johnson, Massac, Pope, Saline, Union and Williamson counties. The area is bordered on the east and south by the Ohio River and on the west by the Mississippi River. The boundary of the Forest encompasses parts of three physiographic provinces, including extensions of the Ozarks Plateaus, the Interior Low Plateaus, and the Gulf Coastal Plain (Fralish et al. 2002). These three provinces include seven ecological subsections including the Illinois Ozark Hills, Greater Shawnee Hills, Lesser Shawnee Hills, Cretaceous Hills, Mississippi River Alluvial Plain, Lower Ohio-Wabash River Alluvial Plain, and the Ohio-Cache River Alluvial Plain (Fralish et al. 2002). Each of the ecological subsections can be further differentiated into six ecological land types (ELT's). These include southwest slopes, south slopes, ridge top sites, north slopes, low slopes and alluvial sites (Fralish et al. 2002). Forests in these ELT's are predominately western

mesophytic forest dominated by oak-hickory forests on the drier sites and mesophytic species (beech and maple) on the moist sites.

The mix of habitat types on the Forest ranges from mature forest to openland within these three physiographic provinces and provides habitat for many native animals, including 40 Regional Forester Sensitive Species (RFSS), and 9 animal species of viability concern (SVC) for the Forest. These include 8 mammals, 11 birds, 5 reptiles, 4 amphibians, 3 fish, and 18 invertebrates. The role they play in the Forest ecosystem is vital.

Table 5. Past (last ten years), present and reasonably foreseeable future actions, with potential for cumulative effects, within the Forest watersheds (includes Forest Service and private lands).

Action	Scope of Action
Agriculture (cultivated - row-cropping)	About 526,500 acres (past, present and future).
Agriculture (cultivated - row-cropping)	About 526,500 acres (past, present and future).
Agriculture (pastureland)	About 59,200 acres (past, present and future).
Prescribed burning *	About 3,000 acres per year (past). About 10,000 acres (present and future).
Wildfires	About 85 acres per year (past). About 1,000 acres per year (future).
Timber harvest/firewood cutting	About 1,000 acres per year (past, present and future).
Timber stand improvement	About 800 acres per year (past, present and future).
Recreational use **	About 300,000 people visited the Forest for recreation. About 37,000 for horseback riding About 150,000 for hiking or walking About 37,000 for hunting About 16,000 for fishing About 5,000 for gathering forest products (mushrooms, berries, and others). About 600 for bicycling.
ATV use	Variable use in watersheds (past, present and future).
Road (including right of way) maintenance	About 300 miles per year (past, present and future). About 1000 acres per year (past, present and future).
Tree planting	About 500 acres per year (past, present and future).
Utility right of way maintenance	About 250 miles per year maintained with herbicide (past, present and future).
Trail construction, reconstruction and maintenance	About 75 miles maintained per year (past, present and future). About 10 miles per year constructed or reconstructed.
Non-system trails	Estimate less than 100 miles of trail (past, present and future).
Special-use permits (telephone, electric, water and driveways).	Estimate less than 20 acres per year (past, present and future).
Invasive species control (private land)	About 200 acres treatment per year (past and present). About 400 acres herbicide treatment (future).
Openlands management	Disking and planting about 200 acres (past). Disking and planting about 100 acres (future).
Residential development	

The revised RFSS list for the Forest is for 2011, while the SVC list is from the Forest Plan (USFS 2006, Appendix H). Table 6 below lists the RFSS grouped by animal class. Table 7 lists the SVC species by animal class. The geographic boundary of cumulative effects for RFSS and SVC species will be different for each species based upon their distribution and/or habitat distribution in the project areas. The temporal boundary for the cumulative effects analysis is the 10-15 year life of the Forest Plan (2006) for present and future actions. The planned actions on the Forest for the next 10-15 years are shown in Table 5. Actions on non-federal land in the project area vicinity are anticipated to be similar to present actions on these areas during this timeframe. The temporal boundary for past actions is the past 10 years. Any projects beyond ten years in the past are considered part of the baseline.

The RFSS and SVC species in Tables 6 and 7 will be grouped for this analysis as follows: Aquatic RFSS and SVC, Cave Obligate RFSS and SVC, Grassland/Old Field specific RFSS and SVC, Upland and Bottomland Hardwood Forest Dependent RFSS and SVC, and Cliff Dependent RFSS and SVC. Some species may be discussed as part of more than one group where and when different habitats are important parts of their life cycle at different times of year or for different life cycle needs.

Table 6. Regional Forester Sensitive Species

Scientific Name	Common Name	Habitat	Comment
Invertebrates			
Crangonyx anomalus	Anomalous spring amphipod	Subterranean and surface springs	Found only in the Lusk Creek drainage
Crangonyx packardi	Packard cave amphipod	Subterranean and surface springs	Documented in Hardin County near Forest
Ligumia recta	Black sandshell	Ohio and Mississippi Rivers and tributaries	Documented in Massac and Pulaski Counties
Sinella cavernarum	Cavernicolous springtail	Caves	Equality Cave, Brown's Hole Cave
Bachtrurus brachycaudus	Short-tailed bactruid	Subterranean and spring seeps	
Caecidotea bicrenata whitei	A cave - obligate isopod	Subterranean and surface springs	Only three records in IL, two of which are in Union County, IL
Caecidotea stygia	A cave isopod	Subterranean and surface springs	Documented in Johnson and Hardin Counties near Forest
Stenotrema (Euchemotrema) hubrichti	Carrinate pillsnail	Rock (limestone) ledges in the Pine Hills section of the Larue/Pine Hills/Otter Pond Research Natural Area (RNA) (Anderson 2005).	Populations occur on the Forest in the LaRue-Pine Hills RNA (Anderson 2005).
Toxolasma lividus	Purple liliput	This species is reported from the headwaters of small to medium sized rivers and some lakes (Cummings and Mayer 1992).	This species is not known from the proposed NA but is suspected to occur in extreme NE areas of the project vicinity (Cummings and Mayer 1992).
Pseudosinella argentea	Springtail	Subterranean obligate debris (Nature Serve 2009).	Suspected to occur in caves on the Forest since these are within the range of the species (Dr. J. Lewis, personal communication).
Caecidotea beattyi	Cave obligate isopod	Subaquatic, subterranean obligate debris (Nature Serve 2009).	Suspected to occur in caves on the Forest since these are within the range of the species (Dr. J. Lewis, personal communication).
Ergodesmus remingtoni	Millipede	Subterranean obligate debris (Nature Serve 2009).	Suspected to occur in caves on the Forest since these are within the range of the species (Dr. J. Lewis, personal communication)..
Gammarus bousfieldi	Bousfield's amphipod	Found in pools with little current, deep mud-detritus bottom, and emergent vegetation in high gradient streams debris (Nature Serve 2009)..	Known from Hardin, Massac, and Pulaski counties in Southern Illinois (Dr. J. Lewis, personal communication).

Table 6. Regional Forester Sensitive Species			
Scientific Name	**Common Name**	**Habitat**	**Comment**
Orconectes indianensis	Indiana crayfish	The Indiana crayfish lives in rocky riffles and pools of small to medium-sized streams (Page, 1985). In Illinois and Indiana, the Indiana crayfish usually occurs in first, second, or third order streams. Within these streams, the species is frequently found under rocks and in woody debris. Brown (1955) reported finding some Indiana crayfish in shallow ("several inches") burrows under rocks in streambeds. Page and Mottesi (1995) reported collecting the species exclusively from sites with water depths less than 50 cm.	The Indiana Crayfish occurs in the lower Wabash and Ohio river drainages in extreme southeastern Illinois and southwestern Indiana (Taylor 2002a). In Illinois, the species is historically known to occur in Brushy Slough (Wabash River drainage), the Saline River drainage, and Honey and Rock Creeks (Ohio River drainage). It is known from the following counties and streams in Illinois: Gallatin County—Eagle Creek and Robinette Creek; Hardin County—Honey Creek, Sheridan Branch, and Rock Creek; Johnson County—Clifty Creek and Sugar Creek; Pope County—Burden Creek; Saline County—Little Saline River and Rock Branch; White County—Brushy Slough; and Williamson County—South Fork Saline River and Sugar Creek (Taylor 2002a).
Orconectes kentuckiensis	Kentucky crayfish	Common in small to large streams ranging in width from 2 to 8 m with bottom substrates of cobble or large gravel. In these streams the species can usually be found under the cobble or gravel. While Page (1985) reported the species almost exclusively from rocky pools, the author has found that in Kentucky it occurs most commonly in flowing riffles averaging 0.4 m in depth. The Kentucky crayfish has also occasionally been collected from woody debris piles in mud bottom streams (Rhoades, 1944).	In Illinois, the species is historically known to only occur in Big, Hosick, and Peters creeks, three direct tributaries of the Ohio River in Hardin Co (Taylor 2002b).
Orconectes placidus	Big-claw crayfish	*Orconectes placidus* occupies rocky riffles and pools with scattered cobble or fractured bedrock in small to large-sized streams and rivers (Page, 1985). Within these streams and river, the species is frequently found under rocks or cobble. Large individuals are occasionally collected from woody debris in slower flowing regions of streams or pools. The species usually occurs at water depths ranging from 0.1 to 1.0 m. In Illinois, *O. placidus* is known only from first, second, or third order streams. In Kentucky, the species usually occurs in second to fifth order streams.	It occurs in a single direct tributary of the Ohio, the Big Creek drainage in Hardin Co (Taylor 2002c).
Sphalloplana hubrichti	Hubricht's cave flatworm	Subaquatic, subterranean obligate debris (Nature Serve 2009)	Not known from the Forest but suspected in Forest caves (Dr. J. Lewis, personal communication).
Stygobromus subtilis	Subtle cave amphipod	Groundwater seeps and drip pools in caves (Lewis 2002).	Known from one, historical location on the Forest in Jackson County, Toothless Cave. However there is some karst habitat in other areas of the Forest that could be considered, unoccupied, suitable habitat (Lewis 2002).

Table 6. Regional Forester Sensitive Species			
Scientific Name	**Common Name**	**Habitat**	**Comment**
Fish			
Lepomis symmetricus	Bantam sunfish	Typically inhabits sloughs, oxbows, ponds, backwaters, lakes, and swamps. The vegetated margins are dominated by *Nymphaea advena* (spatterdock), *Nelumbo lutea* (American lotus), *Sagittaria latifolia* (common arrowhead), *Ceratophyllum demersum* (coon tail), and *Lemna* spp. (duckweed) and are the preferred habitat for this fish. Substrates commonly consist of detritus, mud, and silt, with some sand (Zeman and Burr 2004).	Known from Clear Creek and Running Lake Ditch drainages on the Forest. It is known from Larue-Pine Hills RNA in Larue Swamp (Zeman and Burr 2004).
Lepomis miniatus	Redspotted sunfish	Swamps, backwater sloughs, bottomland lakes, pools of creeks, and small to medium rivers	Pine Hills Swamp, Wolf Lake area, Clear Creek
Reptiles			
Nerodia cyclopion	Mississippi green watersnake	Bald cypress-water tupelo backwater areas.	Known only from Pine Hills RNA
Tantilla gracilis	Flat-headed snake	Rocky wooded hillsides, forest edges, pine-oak uplands, pine woods.	Known only from Pine Hills RNA
Crotalus horridus	Timber rattlesnake	High, dry ridges with oak-hickory forest interspersed with open areas, deciduous forest, hardwood forests, river bottoms, swampy areas and floodplains, cane fields. Hibernacula usually in rocky area with underground crevices, fissures, talus (rock slide), and open scree slopes (Brandon 2005a).	Known to occur in Alexander, Hardin, Gallatin, Jackson, Johnson, Pope, Saline, Williamson and Union Counties on the Forest and considered an uncommon species across the Forest (Brandon 2005a).
Macroclemys temminckii	Alligator snapping turtle	Slow moving, deep water of rivers, sloughs, oxbows, swamps, bayous, and ponds near rivers, Shallow creeks that are tributary to occupied rivers with mud bottom and some aquatic vegetation but may use sand-bottomed creeks. Almost entirely aquatic; rarely out of water except to nest (Nature Serve 2009).	Known to historically occur in Jackson and Union Counties in aquatic habitats within bottomland and floodplain forests (Nature Serve 2009).
Nerodia erythrogaster neglecta	Northern Copperbelly watersnake	The species is a semi-aquatic snake of warm swampy woodlands and bottomland hardwood forests. It frequents all types of perennial, fresh- water bodies (Brandon 2005b).	On the Forest, the species is known or suspected from Johnson, Pope, Saline, Hardin, Massac, and Gallatin Counties (Brandon 2005b).
Amphibians			
Pseudacris streckeri illinoensis	Illinois chorus frog	Sand prairies, open sandy areas of river lowlands	Documented in Alexander County

Table 6. Regional Forester Sensitive Species			
Scientific Name	**Common Name**	**Habitat**	**Comment**
Gastrophryne carolinensis	Eastern narrow-mouth toad	Open moist areas with ground cover, ponds, lakes, swamp edges, marshy fields, sandy loam soils	Only occurs on national forest lands in IL.
Hyla avivoca	Bird-voiced treefrog	Forested and swampy floodplains of large rivers and smaller streams with semi-permanent and permanent pools that support stands of baldcypress and tupelo trees (Brandon 2005c;)	Known to occur in Jackson, Johnson, Pope, Pulaski, Union, and Alexander Counties in Southern Illinois and on the Forest (Brandon 2005c).
Birds			
Ammodramus henslowii	Henslow's sparrow	Unmowed or burned, large-sized (>40 acre) grasslands (USDA Forest Service 2003a).	Known to occur in Jackson, Johnson, Pope, Saline, and Union Counties in Southern Illinois and on the Forest in Pope and Johnson Counties in three, large openlands (Shawnee National Forest Bird Monitoring Information 1990-2009).
Dendroica cerulea	Cerulean warbler	Forested wetlands, riparian areas. Mixed hardwood forests (USDA Forest Service 2003b).	Species is documented occurring in one of the proposed NA: LaRue-Pine Hills RNA and the surrounding hardwoods. Some, unoccupied, suitable habitat maybe present in other areas (Shawnee National Forest Bird Monitoring Information 1990-2009).
Lanius ludovicianus	Loggerhead shrike	Openland with scattered trees and shrubs (Maddox and Robinson 2005).	Known to occur in Gallatin, Hardin, Jackson, Johnson, Massac, Pope, Saline, Union, and Williamson counties in Southern Illinois but only in one location on the Forest in Pope County (Maddox and Robinson 2005). No known populations in site-specific project areas. Some unoccupied, suitable, habitat present in project vicinities on private land.
Limnothlypis swainsonii	Swainson's warbler	Deciduous floodplain and swamp forests; requires areas with deep shade from both canopy and understory cover (Eddleman 2005).	Historically known to occur on the Forest in Jackson county (Cave Valley) (Eddleman 2005).
Haliaeetus leucocephalus	Bald eagle	Mature forest and snags bordering or very near large, perennial bodies of water with good fish populations (USFWS 1983).	Known to occur in all counties of Southern Illinois including on the Forest. No known nesting pairs in the proposed NA prescribed fire treatment areas.
Mammals			
Corynorhinus rafinesquii	Rafinesque's big-eared bat	Forested wetlands and riparian areas, snags and hollow trees, old, abandoned buildings in bottomland forests (BCI 2001).	Known from historical information for Jackson County and current information from Pulaski, Pope and Alexander counties in Southern Illinois. Known only from Pope County on the Forest. Some unoccupied, suitable habitat within the LaRue-Pine Hills area.
Myotis austroriparius	Southeastern myotis	Roost in a variety of shelters including caves, mines, bridges, buildings, culverts, and tree hollows. During winter, they typically hibernate in tightly packed clusters in caves and mines (BCI 2001).	Known from Saline, Pope, Pulaski, Alexander and Union counties. Known from the Forest in Saline and Pope counties (Shawnee National Forest Monitoring Reports 2005-2008).

Table 6. Regional Forester Sensitive Species			
Scientific Name	**Common Name**	**Habitat**	**Comment**
Myotis leibii	Eastern small-footed bat	Caves and mines in fall and winter and trees with exfoliated bark, rock outcrops and caves in spring and summer (BCI 2001).	Known from the Forest and in Illinois only from Johnson County (Steffen et. al. 2006) and Pope County (Whitby et.al 2011). Some unoccupied, suitable habitats (small caves and some sandstone bluffs) are present on the Forest.
Neotoma floridana	Eastern woodrat	Wooded areas, ravines, floodplain forests, and swamps (Monty and Feldhamer 2002).	Known to occur in Jackson, Union, Saline, Hardin, Gallatin, and Pope counties with wild (non-reintroduced) populations only in Jackson and Union counties in the Illinois Ozark Natural Division (Monty and Feldhamer 2002) .
Myotis lucifigus	Little brown bat	Hibernacula: caves and mines Maternity Roosts: dead trees with sloughing bark, man-made structures, abandoned buildings	Distributed throughout southern Illinois where suitable habitat is present
Myotis septentrionalis	Northern long-eared myotis	Hibernacula: caves and mines Maternity Roosts: dead trees with sloughing bark, man-made structures, abandoned	Distributed throughout southern Illinois where suitable habitat is present
Perimyotis subflavus	Tri-colored bat	Hibernacula: caves and mines Maternity Roosts: green foliage within tree canopy	Distributed throughout southern Illinois where suitable habitat is present

Table 7. Species of Viability Concern (SVC)			
Scientific Name	**Common Name**	**Habitat**	**Occurrence**
Fish			
Forbesichthys agassizii	Spring cavefish	Subterranean but found in mouths of springs and cave streams and is occasionally washed out into streams or pools when water table is high. Swims in tiles or springs at night, hides under stones in spring runs by day. Spawns in underground waters. (Smith 1979, USDA Forest Service-Species Literature Summary SVE 2003c, and Nature Serve 2009a).	Known from one specific project area (LaRue-Pine Hills RNA) and from multi-locations in Clear Creek and Big Creek and one location in Lusk Creek (Bear Track Hollow) watersheds on the Forest ((USDA Forest Service-Species Literature Summary SVE 2003c and Nature Serve 2009).
Amphibians			
Hyla versicolor	Gray treefrog	Upland and bottomland hardwood forests under bark, in cavities, and under leaves; and shallow woodland ponds and lakes, swamps, and potholes (USDA Forest Service-Species Literature Summary SVE 2003d).	Known from the Forest in all counties (USDA Forest Service-Species Literature Summary SVE 2003d).
Birds			
Colinus virginianus	Northern bobwhite	Openland and forest-edge (USDA Forest Service-Species Literature Summary SVE 2003e)	Known to occur on the Forest in all counties (Shawnee National Forest Monitoring Reports 2005-2008). Habitat present in project area.

Helmitheros vermivorum	Worm-eating warbler	Riparian areas, hardwood forests, and woodlands (USDA Forest Service-Species Literature Summary SVE 2003f)	Known to occur on the Forest in all counties (Shawnee National Forest Monitoring Reports 2005-2008). Habitat present in project area.
Hylocichla mustelina	Wood thrush	Forested wetlands, riparian areas, hardwood and mixed forests, woodlands (USDA Forest Service-Species Literature Summary SVE 2003g)	Known to occur on the Forest in all counties (Shawnee National Forest Monitoring Reports 2005-2008). Habitat present in project area.
Icteria virens	Yellow breasted chat	Forested wetlands, shrubland, bottomland hardwoods (USDA Forest Service-Species Literature Summary SVE 2003h).	Known to occur on the Forest in all counties (Shawnee National Forest Monitoring Reports 2005-2008). Habitat present in project area.
Melanerpes erythrocephalus	Red-headed woodpecker	Riparian areas, open woodlands with scattered trees (Nature Serve 2009).	Known resident in the Shawnee Hills and common migrant and resident in the Big Muddy and Mississippi River floodplains (Robinson 1996).
Scolopax minor	American woodcock	Forested wetlands, riparian areas, hardwood/mixed forests, grasslands, old fields, and woodlands (Nature Serve 2009).	Known to occur in the project area in all counties. Habitat present in project area (Robinson 2006).
Mammals			
Lutra canadensis	Northern river otter	Primarily along rivers, ponds, marshes, and lakes in wooded areas(USDA Forest Service-Species Literature Summary SVE 2003i)	Known to occur on the Forest in all counties (USDA Forest Service-Species Literature Summary SVE 2003i). Habitat present in project area.

All Effects on Aquatic RFSS and SVC

Included in this grouping are totally aquatic species that live most or all of their life cycle in perennial, fresh-water habitats and are known or suspected from specific project areas or within the project area vicinities. Prey for most of these species is also primarily, aquatic species. The aquatic RFSS and SVC species in this analysis include three invertabrates: black sandshell, purple liliput, and Bousfields amphipod; three fish: spring cavefish, redspotted sunfish and bantam sunfish; three reptiles: alligator snapping turtle, Mississippi green watersnake and northern copperbelly watersnake; four amphibians: bird-voiced treefrog, gray treefrog, Illinois chorus frog, and eastern narrowmouth toad; one bird: bald eagle; and one mammal: northern river otter. The bald eagle, gray treefrog, and spring cavefish will also be included and discussed associated with other habitat groupings below. The bald eagle forages primarily in aquatic environments and much of its prey base is aquatic animals, but it builds its nest in bottomland and upland hardwood forests near aquatic environments. The gray treefrog breeds in aquatic environments, primarily ephemeral pools, but lives most of its life in trees in upland and bottomland hardwood forests. Spring cavefish spends much of its life cycle in spring runs, perennial streams, and swamps, but also in aquatic habitats underground in a number of cave systems. Tables 6 and 7 above identify the habitat and known or historical distribution for the species.

ALTERNATIVE 1

Direct and Indirect Effects

No action should result in no direct effects on aquatic RFSS and SVC mammals, birds, reptiles, amphibians, fish, and invertebrates as no actions are planned near perennial streams that could directly affect the species. No indirect effects on potential or known habitats are predicted as no measurable sedimentation or herbicide residue would occur in potential or known habitats for these species as a result of this alternative. There may be a small amount of soil disturbance adjacent to aquatic environments as weeds are pulled or dug out of the ground, but these actions are unlikely to have any measurable effect in the watersheds were they occur and subsequently on RFSS and SVC mammals, birds, reptiles, amphibians, fish, and invertebrates because of the small areas treated, the short duration of the treatments and the application of design

criteria will quickly stabilize soil to prevent off-site movement. Spot-torching near streams would not have any effects on sedimentation of adjacent streams as few plants would killed in any one area and slowly, decomposing roots of fire-killed plants would hold the soil in place until live roots from new, native plants colonized the area following invasive plant death and decomposition.

ALTERNATIVE 2

Direct and Indirect Effects

1. Prescribed burning – Prescribed burning would be used on a broader scale to treat barren and oak forest areas and in other habitats as needed to control the spread of invasives. The size of the individual burning units would range from 40-3400 acres with about 12,000 acres in total that would be treated within and adjacent to natural areas. Burns would take advantage of existing man-made and natural firelines, such as rivers and streams, rock bluffs, and roads to reduce the need to construct new fire line and reduce soil impacts. Standards and guidelines in the Forest Plan and specific ones developed for planned actions (identified in Design Criteria for All Action Alternatives (Table 4 above) would protect aquatic environments during prescribed burning operations.

No heavy equipment will be used in the aquatic environment. However, small areas adjacent to potential stream habitats could be treated using bulldozers to create small firelines. Overall, dozer lines would not be extensively used adjacent to rivers and streams and other aquatic or wetland habitats in accordance with Forest Plan standards and guidelines for bare soil exposure limits (Forest Plan 2006, page 41). Constructed fire lines will utilize water bars and soil stabilization practices in accordance with Design Criteria. All of the above will limit the amounts of exposed soil that would be potentially available for movement into aquatic environments in project areas and thus minimize the siltation in the water that may interfere with mussel filtration, fish feeding or spawning. Soil movement is also expected to be minimal related to fireline construction due to the small and scattered areas affected, the limited time of treatment and the application of design criteria which will reduce potential effects to aquatic species.

The proposed alternatives and actions could have some, possible, indirect effects on potential habitats for aquatic species with the most indirect effects in the Barren Creek, Running Lake Ditch, and Bay Creek watersheds where prescribed burning could affect areas greater than 1000 acres at any one time. However, even in these watersheds, burning treatments of ecological communities and invasives locations within and adjacent to natural areas, including some areas adjacent to aquatic environments are not likely to have measurable, indirect effects on aquatic species with the implementation of standards and guidelines in the Forest Plan and specific design criteria developed for this project (Table4 Above). In addition, because the riparian corridor adjacent to aquatic environments remains moist throughout the majority of the year, it is unlikely available fuel (in the form of vegetation) will carry extensively in these corridors to the water's edge and as such there should be a barrier for sediment movement to the aquatic environments in place during and after burns. Prescribed burns are also carefully planned to ensure that a layer of organic matter remains after the burn is completed and that there are some unburned areas within burned units. In burned areas there is a duff layer of 1-2 inch thickness remaining over all or most of prescribed burn units across the Forest. All of the above would provide layers of filtering, minimizing the chances of soil movement into aquatic environments.

In summary, burning as planned in Alternative 2 would have minor negative effects on water quality and sedimentation. Thus, overall within known and potentially suitable habitats of aquatic RFSS and SVC mammals, birds, reptiles, amphibians, fish, and invertebrates, the indirect effects on these aquatic species would be minimal and immeasurable.

2. Tree and shrub cutting and treatment – This will involve the use of chainsaws to cut and girdle trees and shrubs in natural areas with little if any associated soil disturbance. Some stumps would be sprayed on cut stumps or trees and shrubs would be treated with a basal bark treatment both of which would involve hand application of herbicides. Glyphosate and triclopyr would be used to treat some stumps and/or girdled trees and shrubs. Since treatments would involve hand applications versus spraying, there would be no or very

little chance of off-site movement of herbicides into known or potential suitable aquatic habitats for aquatic RFSS and SVC species. Also only chemical formulas of both herbicides that are approved for aquatic use would be used in any project locations within 100 feet of aquatic areas. There would also be no soil disturbance associated with this planned action. Therefore there would be no indirect effects on populations of aquatic RFSS and SVC species within or adjacent to the project areas.

3. Herbicide Treatment – Appendix A shows all the herbicides proposed for use and compares their characteristics. Five herbicides may be used. Potential indirect effects could occur if the food chain (primarily aquatic invertebrates) is affected. Chemical control will not affect soil erosion because it would kill but would not physically remove plants or their root systems. The dead plants will continue to stabilize the soil until new plants re-establish naturally.

The proposed herbicides pose different levels of toxicity concerns to aquatic invertebrates. Prior to registration by the EPA, environmental risks must be evaluated on a variety of plant and animal species. Fish and/or *Daphnia* are used to assess direct and indirect effects to aquatic organisms. Data on toxicity of herbicides to amphibians are more limited than data for fish, mammals, and birds. Quantitative estimates of dose from exposure scenarios for herbicides proposed for this project have not been created for amphibians in the SERA Risk Assessments (Appendix D&E) (2001, 2011a, 2011b, 2011c, 2004a). However, some research suggests that amphibians do not exhibit a general pattern of greater sensitivity than other aquatic organisms (e.g. fish) to herbicides (Tatum, 2004, Perkins et al., 2000). Perkins et al (2000) found that even when the highest recommended rates of either glyphosate or triclopyr were directly applied to developing *X. laevis* embryos, there was no toxic response. Mann and Bidwell (1999) found the LC50 value in a lab environment to range from 3.9 to 15.5 mg/L for Roundup (glyphosate w/surfactant) on larval amphibians. This is similar to the fish tested in the SERA Risk Assessments (Appendix D&E).

However, more recent research suggests that Roundup (glyphosate) is moderately to highly toxic to amphibians. Relyea (2005) found that in six North American species of amphibian larvae, the LC50 ranged from 0.6-2.5 mg/L. In another experiment, Relyea (2005) confirmed the LC50 when there was 96%-100% mortality to larval amphibians and 79% mortality of terrestrial, post metamorphosis frogs and toads when exposed to the maximum concentration of Roundup (3.7 mg/L). These studies represent worst-case scenarios, when a herbicide like Roundup, meant for terrestrial applications, is directly applied to a small body of water or directly to a frog or toad. Implementation of design criteria will prevent the ester formulation of triclopyr, surfactants used with the terrestrial form of glyphosate, and all formulations of picloram from being applied in or near aquatic settings. Furthermore, because of the secretive nature and habitat preference of amphibians, they are less likely to be exposed and therefore affected either directly or indirectly by herbicide treatments.

The ecological risk assessment described in Appendix C suggests that proper use of herbicides, especially at average rather than maximum rates, would pose little risk to aquatic receptors in nearby waterways, although the assessments focused primarily on fish and zooplankton. Only those formulations of glyphosate and other herbicides labeled for use in aquatic settings would be used adjacent to aquatic habitats. Should herbicides enter surface water, their concentration would quickly decline because of mixing and dilution, volatilization, and degradation by sunlight and microorganisms (van Es 1990). Most of the herbicides proposed for use under Alternative 2 are of low toxicity to birds, fish and aquatic invertebrate species and have been demonstrated to pose little toxicological risk to fish and wildlife when used at lower application rates typical for the Forest Service (Appendices B, C, & E). However, some formulations of triclopyr (ester form), some surfactants used with glyphosate (terrestrial form), and picloram are toxic or mildly toxic to fish and aquatic invertebrates. Implementation of design criteria will prevent the ester formulation of triclopyr, surfactants used with the terrestrial form of glyphosate, and all formulations of picloram from being applied in or near aquatic settings. Mixing of labeled chemicals will occur at least 100 feet from aquatic habitats.

The data summarized in Appendix B and the ecological risk assessments summarized in Appendix C generally suggest that these herbicides are not highly toxic to fish. In addition, chemicals proposed for application near aquatic systems are of low toxicity to aquatic invertebrates, so it is unlikely that there would be decreases in invertebrates. Due to the limited extent of proposed treatment areas, the relatively small amounts of herbicide used in any one location, and the ability for these aquatic-labeled herbicides to dilute in fast moving aquatic systems and degrade by sunlight and microorganisms; it is likely that the amount of herbicide that could affect any aquatic environments in the project areas would be far below any of the levels of concern shown for fish and aquatic invertebrates.

Care would also be taken during applications adjacent to waterways to ensure that these herbicides and surfactants do not enter aquatic resources. Label direction would be followed to prevent or minimize any groundwater and surface water contamination from mobile chemicals. Herbicide treatment in riparian areas would follow label direction, specified design criteria, and Forest Plan direction to protect aquatic resources. When herbicides are used according to label specifications, no substantial long-term impacts to water quality, aquatic habitat, or aquatic species are expected.

Overall, while any adverse effects from Alternative 2 would be relatively small and temporary, beneficial effects from eliminating invasives from terrestrial habitats would be more wide spread and long term in plant and animal communities on the Forest.

ALTERNATIVE 3

1. **Cultural methods** – There may be a small amount of soil disturbance adjacent to aquatic environments as weeds are pulled or dug out of the ground, but these actions are unlikely to have any measurable, direct or indirect effect on RFSS and SVC mammals, birds, reptiles, amphibians, fish, and invertebrates because of the small areas treated and the short duration of treatment. Application of design criteria will also quickly stabilize soil to prevent off-site movement.

2. Tree and shrub cutting and mechanical treatments – Effects of tree and shrub cutting would be similar to those described in Alternative 2 above except that no herbicides would be used on cut stumps or girdled trees and shrubs. Effects on aquatic RFSS and SVC mammals, birds, reptiles, amphibians, fish, and invertebrates would be comparable to those described in Alternative 2 above except for possible erosion from soil disturbance due to heavy equipment use. A bulldozer may be used in this alternative for removal of populations of large invasive shrubs and vines from some site-specific areas. Bush-hogging may be used more extensively where possible in this alternative as a treatment and preventative action to control some invasive plants. The majority of these planned actions would have no direct or indirect effect on these RFSS AND SVC mammals, birds, reptiles, amphibians, fish, and invertebrates similar to those described above in Alternative 2.

3. Natural Weed Killers – Hot, soapy, sugar water would be used to spot treat some invasives locations near easily accessible roads and trails. No effects on aquatic RFSS and SVC mammals, birds, reptiles, amphibians, fish, and invertebrates are anticipated from this technique as the small amounts of runoff solution would be quickly absorbed by the surrounding soils. Vinegar and clove oil may be used on other sites. Effectiveness of these natural weed killers is questionable and repeated applications would likely be necessary possibly changing the pH of the treated soils. However, no measurable effect to aquatic RFSS and SVC mammals, birds, reptiles, amphibians, fish, and invertebrates is anticipated.

4. Prescribed Fire – Prescribed burning effects to aquatic RFSS and SVC mammals, reptiles, amphibians, fish, and invertebrates would be similar to what is described above in Alternative 2 for these species since overall burning would be similar.

Although the activities proposed in Alternative 3 may result in the reduction or eradication of some invasives, it is not likely to treat those areas as effectively as Alternative 2 because some IP cannot be eradicated or controlled without the use of chemicals.

Cumulative Effects

Cumulative effects as described by the National Environmental Policy Act (NEPA) are "the impact on the environment which results from the incremental impact of the actions when added to other past, present, and reasonably foreseeable future action regardless of what agency (federal or non-federal) or person undertakes such other actions. Cumulative impacts can result from individually minor but collectively significant actions taking place over a period of time" [40 CFR 1508].

The geographic cumulative effects boundary for aquatic species is their immediate habitat (perennial rivers, streams, lakes, ponds and wetlands) along with the lands which comprise the watersheds (HUC 5 level) for these areas. The geographic boundary for the ten aquatic RFSS and SVC mammals, birds, reptiles, amphibians, fish, and invertebrate species are listed in Table 8 below.

Table 8. Geographic Analysis Boundaries for Aquatic RFSS and SVC Mammals, Birds, Reptiles, Amphibians, Fish, and Invertebrates for Invasive Species Management Project.

Aquatic RFSS and SVC mammals, reptiles, amphibians, fish, and invertebrates species	Geographic Analysis Boundary
Black sandshell	Barren Creek, Bay Creek Ditch
Bousfield's amphipod	Barren Creek, Bay Creek Ditch, Goose Creek-Big Creek, Big Creek, Pinhook Creek-Big Grand Pierre Creek, Beaver Creek-Saline River, Camp Creek-Ohio River
Purple lilliput	Beaver Creek-Saline River and Camp Creek HUC 5 watersheds
Gray treefrog, bald eagle and northern river otter	All HUC 5 watersheds on the Forest
Redspotted sunfish, Mississippi green watersnake	Running Lake Ditch, Harrison Creek-Clear Creek
Bantam sunfish	Running Lake Ditch, Harrison Creek-Clear Creek, and Johnson Creek- Bay Creek HUC 5 watersheds
Spring cavefish	Goose Creek-Big Creek, Big Creek, Running Lake Ditch, Hutchins Creek, Seminary Fork-Clear Creek, Little Lusk Creek-Lusk Creek and Harrison Creek-Clear Creek HUC 5 watersheds
Northern copperbelly watersnake	All the HUC 5 watersheds on the Hidden Springs RD (about 30 HUC 5 watersheds)
Alligator snapping turtle	Town Creek-Big Muddy River, Running Lake Ditch, Harrison Creek-Clear Creek, and Miller Creek watersheds
Eastern narrowmouth toad	Barren Creek, Bay Creek, Little Saline River Little Bay Creek-Bay Creek Hayes Creek, suagar Creek, Little Lusk Creek-Lusk Creek, Little Grand Pierre Creek, Big Grande Pierre Creek
Illinois chorus frog	Harrison Creek-Clear Creek, Sexton Creek-Clear Creek, Sandy Creek
Bird-voiced treefrog	Town Creek-Big Muddy River, Running Lake Ditch, Sexton Creek-Clear Creek, Miller Creek, Little Bay Creek-Bay Creek, Johnson Creek-Bay Creek, Sugar Creek, and Bay Creek Ditch HUC 5 watersheds

These geographic boundaries were determined because these purely aquatic species are limited to these habitats, dispersal of the species being analyzed is limited, and impacts to intermittent waterways could affect perennial habitat. The temporal boundary is 10 years, which is the life of the 2006 Forest Plan and the timeframe that allows for initial and subsequent treatments of invasives infestations. This was determined because known locations should all be able to be treated within that timeframe, and any measurable impacts would be apparent.

Past, present, and reasonably foreseeable future actions that where considered for this cumulative effects analysis are listed in Table 5 above. These include actions on state, private and federal land.

Some of the watersheds for the above 15 species would not be affected by planned actions. For cumulative effects analysis, we will assume that the types and amounts of direct and indirect effects identified above for aquatic RFSS and SVC mammals, birds, reptiles, amphibians, fish, and invertebrates would occur as project

actions in each watershed in relation to the acres of treatment planned in each as part of planned actions. The scope of effects would be less than the project counties in proportion to the amount of land within each watershed.

Because long-term impacts of uncontrolled invasive species infestations on aquatic RFSS and SVC species are not clearly understood, cumulative effects from the implementation of Alternative 1 are difficult to assess. This is because invasives infestations are dynamic; exotic species are spread by humans and wildlife and continue to be documented, and all outbreaks have not been discovered in their entirety. Limited research exists regarding impacts of invasive species on wildlife. While some research shows species benefits from IP, other research shows negative impacts (Russell and Balazs, 1994 and USGS website, 2007). Because native wildlife species evolved with native plants, it makes sense to keep native habitats intact. It is unknown how quickly or how far existing or new invasives will take hold and spread in the ten-fifteen year cumulative effects timeframe if left untreated, but it is unlikely cumulative impacts will occur to the aquatic species.

Past, present, and future actions such as agriculture, prescribed fire, ATV use, road and trail maintenance, utility right-of-way maintenance, and invasive species control contributes to lower water quality, erosion and sedimentation. The proposed actions of alternatives 2 and3 may cumulatively contribute to these environmental impacts. However, these effects would be minor and would not add measurably to the existing effects on aquatic habitats and associated species. Although short-term direct or indirect effects may occur to these species in the form of sedimentation or human disturbance (see aquatic species' analyses), there would be minor to no incremental effect when combined with impacts of other past, present, and reasonably foreseeable future activities identified in Alternatives 2 and 3 for the following reasons:

- Standards and guidelines in the Forest Plan were created to protect aquatic habitats and will be applied with all treatments.
- Implementation of design criteria will further protect aquatic habitats by minimizing the potential for impacts to occur as a result of specific actions proposed in this project.
- Only aquatic labeled herbicide will be used in aquatic systems, and all chemicals will be mixed at least 100 feet from aquatic habitats.
- Chemicals applied to aquatic systems would degrade quickly in soil or water by natural processes.

Consequently, actions proposed in any alternative are not expected to contribute substantially to any measurable increase in cumulative degradation of water quality, aquatic habitat, host species, or aquatic prey.

The implementation of the no action, existing condition would have no effect on the aquatic RFSS and SVC animals since some of the species are not known from existing treatment areas and/or treatments would have little direct or indirect effects on aquatic habitats for these species. The implementation of Alternatives 2-3 may affect but is not likely to adversely affect the aquatic RFSS and SVC animals. This is because it may be possible for direct or indirect adverse effects to occur to individuals. However, for reasons given below, these effects meet the definition of insignificant and discountable.

Several design criteria related to water quality will be implemented to protect these species from potential adverse impacts of treatments proposed in Alternatives 2 and 3. In particular, only formulations approved for aquatic-use would be applied adjacent to wetlands, lakes, and streams and rivers following label direction. Mixing of these chemicals will be done at least 100 feet away from these areas to prevent spills and concentrated chemicals from entering water occupied by rare species. Exposed soils will be promptly re-vegetated to avoid re-colonization by invasives and to stabilize the soil. Fueling or oiling of mechanical equipment and mechanically constructed fire lines for prescribed burning would occur at least 100 feet from aquatic habitats, caves, and mine openings. In addition, effects from herbicide application within the watersheds could occur, but these effects are considered insignificant and discountable given the

implementation of Forest Plan standards and guidelines and design criteria, the scattered location of treatments within a watershed, and the relatively small individual sites being treated.

Beneficial effects from the elimination or reduction of invasives (as proposed in Alternatives 2 and 3) from adjacent terrestrial habitats would be long term. Protecting aquatic habitats and allowing native vegetation to thrive will also benefit various prey and/or host species for the all or some of the fifteen aquatic RFSS and SVC animal species.

All Effects on Cave-Obligate RFSS and SVC

Included in this grouping are animals that live most or all of their life cycle in subterranean environments in caves or mines. These include anonalous spring amphipod, Pachard cave amphipod, springtail, cavernicolous springtail, cave Isopod, two cave-obligate isopods, millipede (*E. remmingtoni),* Hubricht's cave flatworm, subtle cave amphipod, short-tailed bactuid, spring cavefish, eastern small-footed bat, Rafinesques's big-eared bat, little brown bat, northern long-eared myotis, tri-colored bat and southeastern myotis. The spring cavefish is also included and discussed in the aquatic species grouping for RFSS and SVC above, Rafinesque's big-eared bat, little brown bat, northern long-eared myotis, tri-colored bat, and southeastern myotis are also included in the upland and bottomland dependent RFSS and SVC below; eastern small-footed bat is included in the cliff-dependent RFSS below.

Of these species, only the eastern small-footed bat, southeastern myotis, little brown bat, northern long-eared myotis, tri-colored bat, subtle cave amphipod, cavernicolous springtail and spring cavefish are known on the Forest. The other species are suspected to occur in caves on the Forest since the Forest is within their known or historical range. The subtle caved amphipod is known from the Cave Creek-Cedar Creek HUC 5 watershed. The cavernicolous springtail is known from the Cave Hill Natural Area in the Horseshoe Creek-South Fork Saline River watershed. The spring cavefish is known from the Forest in Cave Springs Cave West in the Seminary Fork-Clear Creek HUC 5 watershed, from small aquatic caves in LaRue-Pine Hills RNA-Running Lake Ditch HUC 5 watershed, a spring and small cave in the Harrison Creek-Clear Creek HUC 5 watershed, and from springs and cave systems in Hardin County along Big Creek in the Big Creek and Goose Creek-Big Creek HUC 5 watersheds. The southeastern myotis is known from caves in the Lawler Ditch-Saline River and Barren Creek HUC-5 watersheds. The eastern small-footed bat was recently documented in the Cedar Creek and Little Bay Creek-Bay Creek watersheds. The remaining bats are distributed throughout the Forest where suitable habitat is present.

Caves or karst environments occur in almost all watersheds on the west side of the Forest except for those totally within the Mississippi River floodplain and within most of the watersheds on the west side, being most common in the watersheds of the Lesser Shawnee Hills and Cretaceous Hills ecological subsections.

ALTERNATIVE 1

Direct and Indirect Effects

Alternative 1 would have no direct or indirect effects on potential or known habitats as no measurable sedimentation or herbicide residue would occur in potential or known habitats for these species as a result of this alternative. There may be a small amount of soil disturbance adjacent to aquatic environments as weeds are pulled or dug out of the ground, but these actions are unlikely to have any measurable indirect effects in the watersheds were they occur and subsequently on RFSS and SVC cave-obligate species because of the small areas treated, the short duration of the treatments and the application of design criteria will quickly stabilize soil to prevent off-site movement. Spot-torching near streams would not have any effects on sedimentation of adjacent streams as few plants would be killed in any one area and slowly, decomposing roots of fire-killed plants would hold the soil in place until live roots from new, native plants colonized the area following invasive plant death and decomposition. There should not be any smoke and debris entering cave systems directly or indirectly in this alternative.

ALTERNATIVES 2 AND 3

Direct and Indirect Effects

No direct effects are expected on any of these species from planned actions in Alternatives 2 and 3 because major soil, water, and/or noise disturbances would not occur near cave entrances as a result of standards and guidelines for Indiana and gray bats and design criteria for eastern small-footed bats.

Indirect effects could occur to unknown populations in cave environments as a result of prescribed burning and herbicide treatment and the effects of those actions on sedimentation of perennial and intermittent streams or pesticide contamination beyond treatment sites to aquatic environments without management guidelines. However, planned actions would include standards and guidelines and/or design criteria to prevent these indirect effects. Design criteria would limit use of herbicides near aquatic environments including only allowing the use of those pesticide formulas that are approved for use in or near aquatic areas because they do not persist or spread to aquatic systems beyond project sites and/or do not harm animals. Filter-strip guidelines and design criteria that limit soil disturbance in riparian areas and near cave entrances would greatly reduce the threats of sedimentation and noise into cave environments near project locations. Effects on cave-obligate invertebrates from prescribed burning would be similar to those described above for aquatic species.

Several design criteria related to water quality will be implemented to protect these species from any potential adverse impacts of treatments proposed in Alternatives 2 and 3. In particular, only formulations approved for aquatic-use would be applied adjacent to wetlands, lakes, and streams and rivers following label direction. Mixing of these chemicals will be done at least 100 feet away from these areas to prevent spills and concentrated chemicals from entering water occupied by rare species. Exposed soils will be promptly re-vegetated to avoid re-colonization by invasive and to stabilize the soil. Fueling or oiling of mechanical equipment and mechanically constructed fire lines for prescribed burning would occur at least 100 feet from aquatic habitats, caves, and mine openings. In addition, effects from herbicide application within the watersheds could occur, but these effects are considered insignificant and discountable given the implementation of Forest Plan standards and guidelines and design criteria, the scattered location of treatments within a watershed, and the relatively small individual sites being treated.

Beneficial effects from the elimination or reduction of invasives (as proposed in Alternatives 2 and 3) from adjacent terrestrial habitats would be long term. Protecting aquatic habitats and allowing native vegetation to thrive will also benefit various prey and/or host species for the all or some of the ten cave-obligate RFSS and SVC animal species.

Cumulative Effects

Geographic boundaries for RFSS and SVC cave obligate species are HUC 5-sized watersheds on the Forest that include karst areas and include project-area locations. These are all the HUC 5 watersheds that include the Forest on the east side, with the exception of Neely's Creek- Mississippi River and Flora Creek-Mississippi River watersheds and all HUC-5 watersheds on the east side of the Forest in the lesser Shawnee Hills and Cretaceous Hills Ecological Subsections. The latter excludes most of the extreme northern HUC 5 watersheds on the east side, with exception of Horseshoe Creek-South Fork Saline River.

Some of the proposed project areas for prescribed burning, tree/shrub cutting and girdling, and herbicide treatment are within the geographic boundaries identified above (see attached project map). Past, present, and foreseeable future actions within the geo boundaries for cave obligate species would be similar to those described above for aquatic RFSS and SVC.

The indirect effects of farming, road and trail construction, invasive species control, utility right-of-way maintenance, and development actions on adjacent private lands within the project geographic boundaries and their associated herbicide, fertilizer, and sediment runoffs would continue to have the most pronounced and measurable effects on cave systems and their species in the project areas. This is because of effects of the relatively large amounts of actions and subsequent runoffs of these pollutants on aquatic systems that

directly and indirectly affect known and unknown cave systems in the project area. Alternative 1 would have no direct or indirect effects and thus no cumulative effects on cave obligate RFSS and SVC species.

Sedimentation due to burning and herbicide runoffs from planned actions in Alternatives 2 and 3 may contribute but would not add measurably to the existing effects on cave systems from private lands identified above especially with applications of Forest Plan standards and guidelines and project design criteria. Cumulative effects of these two alternatives would be small and immeasurable on habitat for and populations of cave obligate RFSS and SVC.

All Effects on Grassland/Oldfield-Specific RFSS and SVC

Included in this grouping are animals that live most or all of their life cycle in grassland, oldfield and barrens habitats. These include Henslow's sparrow, loggerhead shrike and northern bobwhite. Henslow's sparrow and loggerhead shrike are only known on the Forest from existing, large openlands on the east side; however, known and unknown suitable habitat may be bisected by road and stream corridor treatments. The northern bobwhite quail is found in oldfields and grasslands throughout the project area on Forest, state and private lands in all of the HUC5 watersheds on the Forest. It is not only a SVC species, but it is also a management indicator species under the Forest Plan.

ALTERNATIVE 1

Direct and Indirect Effects

Alternative 1 should not have any direct effects on the these three species since actions are very limited and no negative impacts to Henslow's sparrow, loggerhead shrike, or bobwhites have been reported or are anticipated. This alternative could have indirect negative effects on the these grassland/oldfield-associated birds as invasives invade and replace native, grassland and openland plant species throughout the project area without more aggressive invasive species treatments. This could result in less native foods for the species as well as loss of preferred, native herbaceous plant cover for nesting, hiding and thermal protection. Documented large declines in bobwhites could already be related to invasive species spread and use of tall fescue in private grasslands and pastures in Midwestern landscapes, replacing natives such as broomsedge and little bluestem grass that are preferred nesting and hiding cover.

ALTERNATIVES 2 AND 3

Direct and Indirect Effects

Alternatives 2 and 3 would have no direct effects on Henslow's sparrow, loggerhead shrikes, or northern bobwhites, as they will move away from burning or herbicide application and burning would happen outside of the nesting seasons for the species when eggs or non-mobile young could be affected. Both alternatives would have beneficial, indirect effects on bobwhites from burning of natural areas (about 12,000 acres) and with Alternative 2 also having beneficial, indirect effects on Henslow's sparrow, loggerhead shrike and bobwhites from herbicide treatments of the worst infestations of invasive plants on the Forest. Burning in the project areas will improve both food and cover plants for bobwhites. Herbicide treatments of invasives on known sites would greatly reduce their spread on the Forest, and this should improve treated grasslands and oldfields by reducing the spread of invasives and replacement of native food and cover plants.

Cumulative Effects

Henslow's sparrow and loggerhead shrike are only known on the Forest from existing, large openlands on the east side of the Forest, outside of the proposed project sites. The geographic boundary for the northern bobwhite is the entire Forest, including all the watersheds where actions are planned as part of Alternatives 2 and 3. All of the proposed project areas for prescribed burning, tree/shrub cutting and girdling, and herbicide treatment are within the geographic boundaries identified above (see attached project map). Past, present and foreseeable future actions within the geographic boundaries for the grassland/oldfield RFSS and SVC would be similar to those described above for aquatic RFSS and SVC.

The indirect effects of farming and human development on adjacent private lands within the geographic boundaries and their associated overall, negative impacts on nesting and feeding habitats and escape cover

for Henslow's sparrow, loggerhead shrikes and bobwhites would continue to have pronounced effects on the species. Adverse effects on these grassland/oldfield species have occurred and will continue to occur from the agricultural use of monocultures of non-native perennial grasses such as fescue for pasture, from farming actions that eliminate waste and odd areas dominated by native, herbaceous weeds; from the maturation of historical oldfields and/or from the loss of oldfields and native grasslands to development and agriculture; all of which greatly reduce food and cover. Prescribed burning on the Forest as part of planned actions in Alternatives 2 and 3 would have measurable, positive effects on habitats (improvement of food and cover) for bobwhites but a much smaller, incremental positive effect on populations of bobwhites due to the much larger negative effects on the bobwhite populations from management of adjacent private lands. Prescribed burning in the planned project areas would have no effect on Henslow's sparrow and loggerhead shrike because they do not occur in the project areas; however, herbicide treatments of invasives would greatly reduce their spread on the Forest, and this should improve treated grasslands and oldfields nearby by reducing the spread of invasives and replacement of native food and cover plants.

Cumulative effect of Alternatives 2 and 3 on Henslow's sparrow and loggerhead shrike would be maintenance of current suitable food and cover by controlling the potential spread of invasives onto suitable grassland habitats, resulting in no effect on the known populations of these species. Current populations should be maintained on the Forest.

Cumulative effects of Alternatives 2 and 3 on the northern bobwhite would be moderate, overall improvements of food and cover for the species resulting in minor, overall improvements in populations for the species.

All Effects on Cliff-Dependent RFSS and SVC

Included in this grouping are animals that live most or all of their life cycle associated with cliff habitats. These include eastern small-footed bat, eastern woodrat, timber rattlesnake and carinate pillsnail. Habitats for these species are listed in Table 1 above.

The eastern small-footed bat is known from barrens area on the Forest in Johnson and Pope Counties, but is thought to occur associated with large sandstone bluff areas. The known location for the species is one of the project areas, Fink Sandstone Natural Area. Unoccupied suitable, summer habitat for the species within the project areas includes Reids Chapel, Bell Smith Springs, Double Branch Hole, Jackson Hole, Bulge Hole, Odum Tract, Hayes Creek/Fox Den and Russel Cemetery Natural Areas. Unoccupied suitable, winter habitat for the species within the project areas includes Ava Natural Area.

The eastern woodrat is known from the LaRue-Pine Hills Research Natural Area (RNA), Fountain Bluff, and High Knob project areas and their vicinities. The latter area is a reintroduced population.

The timber rattlesnake is uncommon throughout all the project areas, being most abundant in the vicinities of project areas on the west side of the Forest.

The carinate pillsnail is known only from eight small populations in LaRue-Pine Hills RNA project site on steep, rock outcrops and ledges.

ALTERNATIVE 1 – NO ACTION

Direct and Indirect Effects

Alternative 1 would not have any direct effects on any of the cliff-dependent RFSS as no actions beyond pulling and spot-torching of invasives would occur. These actions could affect the carinate pillsnail if they occurred in known habitats. To date, they have not occurred in known habitats for this species. Indirect negative effects could occur to all the above RFSS cliff species under Alternative 1, as their habitats would change as invasives are not adequately controlled. Their prey or food that evolved with native vegetation or that is native vegetation would diminish. Eastern woodrat in Fountain Bluff and LaRue-Pine Hills project areas and the carinate pillsnail in the LaRue-Pine Hills project areas would be most affected and are most

threatened by invasives infestations of native habitats, such as garlic mustard populations that occur in both project areas in close proximity to known habitats.

ALTERNATIVES 2 AND 3

Direct and Indirect Effects

Alternatives 2 and 3 could have some negative, direct effects on all of the above species from burning and/or ingestion of herbicides in some of the project areas. However, design criteria would alleviate most of these negative effects by avoiding key, known habitats for all four species. Burning in both alternatives would have indirect, positive effects on habitats for the timber rattlesnake and eastern woodrat as dry, upland forests and barrens in association with cliff habitats are maintained and/or improved and, thus, food and/or cover for both would be improved. Herbicide application associated with large-scale control of invasives would have a positive, indirect effect on habitat for carinate pillsnail, eastern woodrat and timber rattlesnake as native plants would prosper as invasives would diminish in the vicinity of cliff habitats and provide additional or continued food and cover for all three species.

Cumulative effects

Geographic boundaries for the cumulative effects on the cliff-dependent RFSS are the Running Lake Ditch HUC-5 watersheds associated with known habitats for carinate pillsnail, the HUC-5 watersheds with project areas and known habitats for the eastern woodrat; all HUC-5 watersheds on the Forest with project areas for timber rattlesnake, and all HUC-5 watersheds with project areas in the Greater Shawnee Hills Ecological Subsection (sandstone dominated) for the eastern small-footed bat.

Most if not all of the remaining habitats for these species are on the Forest or IDNR property. Past actions in these areas have been acquisition and restoration of highly degraded forest land and sandstone bluff areas acquired in the 1930's and 1940's. Some of this land was planted to non-native pine plantations by the Forest Service. Since acquisition and restoration, some timber management actions have occurred, including a variety of regeneration harvests and thinnings, some prescribed burning associated with pine thinnings, and natural area management of native barrens and dry, upland hardwood forests. Present actions include continued natural area management (burning and tree and shrub thinnings; hand-pulling and spot-torching invasives and reduction, restoration and/or elimination of horse trails), future management would include a continuation of past and present actions.

Cumulative effects for the carinate pillsnail for Alternative 1 would be long-term, negative effects on its habitat as native, cliff plant species are replaced by invasives, primarily garlic mustard, without implementation of chemical control measures. Alternative 1 would result in negative cumulative effects on populations of the carinate pillsnail as habitat declines in diversity and quality. Cumulative effects for the carinate pillsnail for Alternatives 2 and 3 would be positive, as known cliff habitats dominated by native plants are protected by controlling invasives and improving overall native plant diversity. Alternatives 2 and 3 would maintain current populations of the species in known cliff locations.

Cumulative effects of Alternative 1 for the eastern woodrat and timber rattlesnake would be short- and long-term, negative effects on their habitats as native cliff and dry, upland forest habitats are replaced by invasives, including successional changes to maple-dominated forests without fire disturbances, as well as invasion by garlic mustard and other invasives. Cumulative effects of Alternative 1 on woodrat and timber rattlesnake populations would be negative, as habitat is reduced in native plant diversity and abundance. Cumulative effects of Alternatives 2 and 3 on the eastern woodrat and timber rattlesnake would be positive on habitats dominated by native plants on cliffs and in adjacent, diverse, dry upland forests. Cumulative effects on populations of woodrats and rattlesnakes would also be positive following improvement and maintenance of native habitats.

Alternative 1 would have no effect and therefore no cumulative effects on eastern small-footed bats. Alternatives 2 and 3 would have no cumulative effects on the eastern small-footed bat with implementation of design criteria protecting cliff areas and caves from any, direct negative effects from prescribed burning

on the species. Known and unknown populations of eastern small-footed bats should be maintained on the Forest.

All Effects on Upland and Bottomland Hardwood Forest-Dependent RFSS and SVC

Included in this grouping are animals that live most or all of their life cycle in upland or bottomland hardwood forest habitats. These include cerulean warbler, Swainson's warbler, bald eagle, Rafinesque's big-eared bat, southeastern myotis, little brown bat, northern long-eared myotis, tri-colored bat, eastern woodrat, flat-headed snake, timber rattlesnake, gray treefrog, bird-voiced treefrog, worm-eating warbler, wood thrush, yellow-breasted chat, red-headed woodpecker and American woodcock.

Swainson's warblers are historically known to occur on the Forest in Jackson County in large contiguous stands of bottomland forest supporting dense stands of giant cane where they nest. They would not be directly affected by any of the planned actions, but could be indirectly affected by the invasion of non-native plants on native forest and herbaceous vegetation and prey species.

Rafinesque's big eared bats prefer forested wetlands and riparian areas, snags and hollow trees in bottomland forests, and old abandoned buildings (BCI 2001). This species would not be directly affected because Forest standards and guidelines and design criteria for the Indiana and gray bat would protect potential roost trees for this species, but could be affected indirectly by effects of invasives on live and dead roost trees and native insect prey, as a result of Alternative 1.

The little brown bat, northern long-eared bat, and tri-colored bat all utilize hardwood forest areas. The northern long-eared and little brown bats prefer dead trees, sloughing bark and man-made structures for maternity roosts and caves/mines for hibernacula. The tri-colored bat prefers the green foliage in tree canopies for maternity roosts and caves or mines for hibernacula. These species would not be directly affected because Forest standards and guidelines and design criteria for the Indiana and gray bat would protect potential roost trees for this species, but could be affected indirectly by effects of invasives on live and dead roost trees and native insect prey, as a result of Alternative 1.

Bald eagles are known to forage in four of the site-specific project and natural areas, Kinkaid and Cedar Lake, Lake of Egypt and LaRue Swamp. Three of those sites would include herbicide use only. Only LaRue Swamp would include some prescribed burning. Effects of herbicide use on bald eagles are covered above in effects on aquatic species. Only prescribed burning could have any effect on bald eagle nesting or roosting. The species is known to nest near Larue Swamp and Lake of Egypt; however, there are no known nests for the species in either of the project areas in those vicinities. Effects on foraging habitat for the species are covered above under effects on aquatic RFSS and SVC species, as the main prey species for the bald eagle are aquatic animals, primarily fish and waterfowl. No known nesting sites would be affected by any of the prescribed burning actions. Alternative 1 would have no effects on roosting habitat for the species. Some feeding perches (live and dead trees near large, permanent water bodies (lakes, reservoirs and rivers) could be affected by burning in the LaRue-Pine Hills project site. However, there is an abundance of roost trees in this vicinity and most would not be affected; therefore, no effects on bald eagle use or populations are predicted as a result of Alternatives 2 and 3.

Southeastern bats, eastern woodrat, timber rattlesnake, gray treefrog, bird-voiced treefrog, worm-eating warbler, wood thrush, yellow-breasted chat, red-headed woodpecker and American woodcock occur or have unoccupied suitable habitat across the Forest. All use all or parts of native, upland and bottomland, hardwood forests for all or parts of their life cycle.

Flat-head snakes are uncommon localized species in upland hardwood/pine stands. This species is documented only from the Larue-Pine Hills RNA. Flat-head snakes could be directly affected by burning and herbicide treatments near den sites and indirectly affected by effects of burning and invasives effects on native forest and herbaceous vegetation and prey species.

Southeastern bats utilize upland and bottomland forests for feeding and some roosting. The species primarily roosts in caves in southern Illinois, but can use large dead and live trees with cavities for maternity roosts as well. The species could be affected directly by prescribed burning when in tree roosts and indirectly by effects of burning and invasives on live and dead roost trees and native insect prey.

Eastern woodrats, timber rattlesnakes, bird-voiced treefrogs and gray treefrogs are uncommon-to-common resident species in upland and bottomland hardwood forests, with woodrats and timber rattlesnakes preferring or more common in oak-hickory forests. Treefrogs are arboreal and feed and rest above the ground in live, hardwood trees. Woodrats sometimes live in the hollows of trees and forage in the herbaceous understories of hardwood forests. Timber rattlesnakes rest and forage in the herbaceous understories of hardwood forests. Treefrogs could be directly affected by herbicide and burning treatments while they are on the ground moving to and from breeding sites, and indirectly affected by effects of burning and invasives on native hardwood forest species and insect prey. Eastern woodrats could be directly affected by burning near den sites and indirectly affected by effects of burning on native trees and herbaceous plants and invasives and replacement of native vegetation. Timber rattlesnakes could be directly affected by burning and herbicide treatments near den sites and indirectly affected by effects of burning and IP invasion effects on native forest and herbaceous vegetation and prey species.

Cerulean warblers, worm-eating warblers, wood thrushes, yellow-breasted chats, red-headed woodpeckers and American woodcocks are common-to-uncommon migratory bird species that seasonally inhabit upland and bottomland forests on the Forest. Worm-eating warblers and American woodcock are ground-nesting species that could be directly affected by herbicide treatment and prescribed burning and indirectly affected by the effects of burning and invasives on native woody and herbaceous vegetation and their prey species. Cerulean warbler is a canopy-nesting species in large, riparian forest species and large white oaks. It is very limited in distribution on the Forest but is known from the LaRue-Pine Hills RNA. It would not be directly affected by any of the planned actions but could be indirectly affected by invasives' effects on native forest and herbaceous vegetation and prey species. The wood thrush and yellow-breasted chats are both mid-canopy and/or shrub-nesting species and could be directly affected by prescribed burning during nesting seasons and indirectly affected by effects of burning and invasives' effects on native forest and herbaceous vegetation and prey species. Finally, the red-headed woodpecker is a cavity-nesting species and could be directly affected by burning during the nesting season and indirectly affected by effects of burning and invasives' effects on native forest and herbaceous vegetation and prey species.

Burning as planned in Alternatives 2 and 3 would occur before and after the nesting season for migratory birds in winter, early spring and fall and as such would not directly affect any of the upland and bottomland, hardwood forest dependent, migratory birds except for the American woodcock that is a very early nesting species. Burning could cause some mortality to American woodcock nests and eggs during early spring burns but not during winter or fall burns.

ALTERNATIVE 1 – NO ACTION

Direct and Indirect Effects

Alternative 1 would have no direct effects on any of the above species, as minor actions such as pulling and spot-torching of individual invasives should not affect any of the above upland and bottomland hardwood forest-dependent RFSS and SVC. Indirect, negative effects could occur on most of the above hardwood forest dependent species, as habitats decline due to associated declines in native, prey abundance and/or preferred native, plant foods and cover when invasives are not controlled in the project areas.

ALTERNATIVE 2 AND 3

Direct and Indirect Effects

Alternatives 2 and 3 would not have any direct effects on most all of the upland and bottomland hardwood dependent species except for grey treefrog and American woodcock from burning. Direct effects would be eliminated on these species either because they are seasonally not present (includes migratory birds not

nesting or migrating to other parts of the Americas and reptiles and mammals that are underground in dens or in caves during burning or herbicide treatment seasons), not affected as nests or roosts are protected by Forest standards and guidelines and/or project design criteria, or are mobile and can move to avoid herbicide and burning impacts.

The eastern woodrat is active during burning and herbicide application seasons. Burning under both alternatives, natural weed treatments in Alternative 3 and herbicide treatments in Alternative 2 would not directly affect the eastern woodrats, as the species is mobile and could evade the fire and spray applicators and application areas. Also, its nests are in locations in rocky bluffs and boulder areas that are rarely if ever affected by prescribed burns due to limited fuels, and many of its known locations would be protected by design criteria for the eastern small-footed bats that protect large rock outcroppings from prescribed fire application.

Direct effect of burning as proposed in Alternatives 2 and 3 on the American woodcock could be the destruction of a few nests and eggs during the early spring burning season. Similarly, the gray treefrog could be directly affected by burning when on the ground during spring breeding seasons. A few of the latter individuals may not be able to avoid the direct effects of fire and could suffer some adult mortality, albeit minor, since most individuals are thought to be able to escape fire fairly easily.

Few if any of the above species would be negatively, indirectly affected by herbicide applications and ingestion of herbicide-treated vegetation or insects contaminated with herbicides. All herbicides proposed for use are not known to be toxic to the any of the above species in the low concentrations that would be dictated by label instructions and actual applications (Appendices B, C, D, and E). The indirect, positive effects of herbicide applications (Alternative 2) and the control of invasives for the benefit of all species would be the maintenance and/or improvement of habitat, including the native vegetation and/or the native prey species that depend upon it.

Burning and some tree and shrub thinning as planned in Alternatives 2 and 3 would have positive, indirect effects for all species. Their native habitats that provide food (native overstory and understory vegetation and native prey) and cover (native overstory and understory vegetation) for all of the above species would be improved and/or maintained.

Cumulative Effects

Geographic boundaries for upland and bottomland hardwood forest-dependent RFSS and SVC species will vary by species or groups of species. For the more common species, or species with more widespread distributions, such as little brown bat, northern long-eared myotis, tri-colored bat, bald eagle, timber rattlesnake, gray treefrog, worm-eating warbler, wood thrush, yellow-breasted chat and American woodcock, the geographic boundaries for cumulative effects would be all HUC-5 watersheds that include project areas on the Forest.

For the eastern woodrat, the geographic boundaries are the HUC-5 watersheds with project areas and known habitats for the eastern woodrat. This includes the following HUC-5 watersheds: Owl Creek-Mississippi River, Town Creek-Big Muddy River, Cave Creek-Cedar Creek, Running Lake Ditch, Hutchins Creek, Black Branch-Eagle Creek, Little Eagle Creek, Beaver Creek-Saline River, Pinhook Creek-Big Grand Pierre Creek, Little Lusk Creek-Lusk Creek, and Lusk Creek. For cerulean warbler the geographic boundaries are the following HUC 5 watersheds: Town-Creek-Big Muddy River, Cave Creek-Cedar Creek, Hutchins Creek, and Running Lake Ditch.

For Swainson's warbler, the geographic boundary is Cave Creek-Cedar Creek HUC-5 watershed. For Rafinesque's big-eared bat, the geographic boundaries are the following HUC 5 watersheds: Lake Creek and Barren Creek. For the southeastern myotis, the geographic boundaries are the following HUC 5 watersheds: Horseshoe Creek-South Fork Saline River, Black Creek-Eagle Creek, Sister Islands-Ohio River and Barren Creek. For red-headed woodpecker, the geographic boundaries are the following HUC 5 watersheds: Worthen Bayou, Owl Creek-Mississippi River, Neely Creek-Mississippi River, Flora Creek-Mississippi River,

Town-Creek-Big Muddy River, Cave Creek-Cedar Creek, Hutchins Creek, Running Lake Ditch, Harrison Creek Clear Creek, Miller Creek, Sexton Creek, and Lake Creek. For the bird-voiced treefrog the geographic boundaries are the following HUC 5 watersheds: Town Creek-Big Muddy River, Running Lake Ditch, Sexton Creek-Clear Creek, Miller Creek, Little Bay Creek-Bay Creek, Johnson Creek-Bay Creek, Sugar Creek, and Bay Creek Ditch.

Temporal boundaries would be 10-15 years, the same as the National Forest Plan (2006).

Past actions would be similar to those identified for the aquatic RFSS and SVC species, especially including timber management involving both even and uneven-aged hardwood forest management actions, including clearcuts up to 40 acres in size, shelterwood harvest cuts of varying sizes, small amounts of group selection and single-tree selection. Past actions also included reforestation, clearing for farming, and thinnings. All the hardwood forest areas were grazed by livestock in the late 19th and early 20th centuries. There have also been some large amounts of prescribed burning in forests prior to National Forest System ownership and, more recently, some small amounts of prescribed burning. Past actions also included active management of small wildlife openings within hardwood forests on Forest land (approximately 3,000 openings) and, more recently, elimination and forest regeneration in most of these openings. Bottomland hardwood forests have also been subjected to small flood events every year and some large flood events in the last 20 years. Wind and ice storm events have also affected much of these hardwood forests historically and especially in the last five years.

Present actions include some of the past timber management actions especially on private forest lands, some deforestation for agricultural and developmental purposes, and small amounts of thinning and reforestation. Future actions would be a continuation of most past and present actions within private and public forests including relatively large amounts of prescribed burning on public forests.

Alternative 1 would have no measurable negative or positive direct effects on any of the other upland and bottomland hardwood-dependent RFSS and SVC species, as few actions and/or changes to the hardwood forests would occur. However, this alternative would have a large, indirect, negative effect on native overstory and understory plant species and, thus, on food and cover for most of upland and hardwood forest dependent-species. These would also be the cumulative effects on these species. These cumulative effects from Alternative 1 on habitats and, subsequently, on populations of upland and bottomland hardwood-dependent, RFSS and SVC would be more pronounced in the long term (10-15 years out) than in the short term (1-5 years out).

Alternatives 2 and 3 would have no, or only minor, negative direct or indirect effects on forest-dependent RFSS and SVC. Both alternatives would have relatively, large positive, indirect effects on forest-dependent RFSS and SVC, as native overstory and understory plants and/or native prey that depend upon them, are maintained or improved in both alternatives, with the most improvement and positive effects resulting from Alternative 2 that includes herbicide applications as well as prescribed burning. These would be the cumulative effects on these species from Alternatives 2 and 3, except that positive effects on all species would be less pronounced overall as some invasives would persist on adjacent, untreated private forest habitats adjoining the Forest and would be even less positive in Alternative 3, as invasives are not totally controlled.

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Appendix A. Comparison of Herbicide Characteristics

Triclopyr (Tu et al. 2001; SERA 2011b)	
Solubility	Offsite movement through surface or sub-surface runoff is a possibility with triclopyr acid, as it is relatively persistent and has only moderate rates of adsorption to soil particles. In water, the salt formulation is soluble, and with adequate sunlight, may degrade in several hours. The ester is not water-soluble and can take significantly longer to degrade. It can bind with the organic fraction of the water column and be transported to the sediments.
Half-life	In soils, degradation occurs primarily through microbial metabolism, but photolysis and hydrolysis can be important as well. The average half-life of triclopyr acid in soils is 30 days.
Toxicity	Both the salt and ester formulations are relatively non-toxic to terrestrial vertebrates and invertebrates. The ester formulation, however, can be extremely toxic to fish and aquatic invertebrates. Based on the limited data available on toxicity to aquatic-phase amphibians, amphibians appear to be less sensitive than fish by a factor of about 4. The toxicity of triclopyr or TCP to reptiles or terrestrial-phase amphibians is not addressed in the available literature.
Toxicity and Bioaccumulation	Both the salt and ester formulations are relatively non-toxic to terrestrial vertebrates and invertebrates. The ester formulation, however, can be extremely toxic to fish and aquatic invertebrates. The hydrophobic nature of the ester formulation allows it to be readily absorbed through fish tissues where it is converted to triclopyr acid which can be accumulated to a toxic level. Most researchers have concluded that if applied properly, triclopyr would not be found in concentrations adequate to harm aquatic organisms. Tendency for triclopyr to dissipate quickly in the environment, which would preclude any problems with bioaccumulation in the food chain.
Glyphosate (Tu et al. 2001; SERA 2011a)	
Solubility	Glyphosate is strongly adsorbed to soil particles, which prevents it from excessive leaching or from being taken-up from the soil by non-target plants. It is degraded primarily by microbial metabolism, but strong adsorption to soil can inhibit microbial metabolism and slow degradation. Photo- and chemical degradation are not significant in the dissipation of glyphosate from soils.
Half-life	The half-life of glyphosate ranges from several weeks to years, but averages two months. In water, glyphosate is rapidly dissipated through adsorption to suspended and bottom sediments, and has a half-life of 12 days to ten weeks.
Toxicity	Glyphosate by itself is of relatively low toxicity to birds, mammals, and fish, and at least one formulation sold as Rodeo® is registered for aquatic use. Some surfactants that are included in some formulations of glyphosate, however, are highly toxic to aquatic organisms, and these formulations are not registered for aquatic use.
Toxicity and Bioaccumulation	Glyphosate by itself is of relatively low toxicity to birds, mammals, and fish, and at least one formulation sold as Rodeo® is registered for aquatic use. Some surfactants that are included in some formulations of glyphosate, however, are highly toxic to aquatic organisms, and these formulations are not registered for aquatic use. Glyphosate does not bioaccumulate in fish. Residue levels not detectable in herbivores after 55 days; carnivores and omnivores at lower risk of detecting long-term residue levels.
Sethoxydim (Tu et al. 2001; SERA 2001) http://pmep.cce.cornell.edu/profiles/extoxnet/pyrethrins-ziram/sethoxydim-ext.html	
Solubility	Because sethoxydim is water-soluble and does not bind strongly with soils, it can be highly mobile. No reports, however, were found referring to water contamination or off-site movement by sethoxydim.
Half-life	The average half-life of sethoxydim in soils is four to five days, but half-lives can range from a few hours to 25 days. Sethoxydim is readily degraded through microbial metabolism and photolysis, and possibly by hydrolysis. Numerous degradation products have been identified, some of which are also toxic to plants.
Toxicity	Sethoxydim is of relatively low toxicity to birds, mammals, and aquatic animals, and has little noticeable impact on soil microbe populations.
Toxicity and Bioaccumulation	Sethoxydim is of relatively low toxicity to birds, mammals, and aquatic animals, and has little noticeable impact on soil microbe populations. The tendency to dissipate quickly precludes any bioaccumulation in the food chain.

Clopyralid (Tu et al. 2001; SERA 2004a)	
Solubility	Clopyralid is highly water-soluble and will not bind with suspended particles in the water column. The inability of clopyralid to bind with soils and its persistence implies that clopyralid has the potential to be highly mobile and a contamination threat to water resources and non-target plant species; although no extensive offsite movement has been documented.
Half-life	Clopyralid's half-life in the environment averages one to two months and ranges up to one year. It is degraded almost entirely by microbial metabolism in soils and aquatic sediments. Clopyralid is not degraded by sunlight or hydrolysis.
Toxicity	Clopyralid can cause severe eye damage if splashed into the eyes during application,but otherwise is non-toxic to fish, birds, mammals, and other animals.
Toxicity and Bioaccumulation	Clopyralid can cause severe eye damage if splashed into the eyes during application, but otherwise is non-toxic to fish, birds, mammals, and other animals. There is no evidence of bioaccumulation.
Picloram (Tu et al. 2001; SERA 2011~~03a~~)	
Solubility	Picloram is water-soluble and does not bind strongly with soil particles and is not degraded rapidly in the environment. It considered highly mobile and persistent and a contamination threat to non-target plants. Extensive offsite movement has been documented for it in the groundwater in 11 states.
Half-life	Picloram's half-life in the environment can range from one month up to one year. It is degraded primarily by microbial metabolism in soils but can be degraded in sunlight when directly exposed to water.
Toxicity	Picloram is not highly toxic to birds, mammals, and aquatic species. Some formulations are highly toxic if inhaled and others can cause severe eye damage if splashed into the eyes.
Toxicity and Bioaccumulation	Because of persistence in the environment, chronic exposure to wildlife is a concern. Studies have found weight loss and liver damage in mammals following long term exposure to high concentrations. It is not recommened for use near water.

Given the small amount of habitat impacted around hibernacula (see analysis in FEIS Appendix F and Appendix B of this biological opinion) and the relatively small number of individuals exposed, the bats are expected to be able to relocate and fitness consequences are not anticipated. In the fall, larger numbers of Indiana bats occupy the habitat within and surrounding hibernacula. During this time bats are accumulating fat reserves and continue to roost in trees to some extent. Habitat around hibernacula is abundant in comparison to the number of bats utilizing these hibernacula (Appendix B). Prescribed fire may also benefit Indiana bats in many ways. High intensity fire may create additional snags and potential roost trees for Indiana bats. Opening the understory would reduce clutter around these potential roost trees improving microclimate diversity and foraging conditions. In addition, oak regeneration should occur in response to the fire, leading to long-term potential roosting habitat on the landscape. The benefits would be increased fitness, shortened gestation periods and improved reproductive success. This could ultimately lead to population stability or increase.

Appendix B. Ecological Risk Assessment Information for Herbicides Proposed for the Non-Native Invasive Plant Control on the Shawnee National Forest.

Risk Assessment Application Rate	Terrestrial Mammals	Birds	Insects	Fish & Other Aquatic Receptors
Glyphosate (Source: SERA 2011a~~03a~~)				
2 lb a.i./acre (average rate) 2.4 a. i./acre (recommended rate for the Shawnee NF applications) 7 lb a. i./acre (maximum rate)	Effects resulting from average application rate are minimal. Some risk for large mammals consuming foliage for an extended period of time in areas treated with maximum application rate.	Effects resulting from average application rate are minimal. Some risk for small birds consuming insects for an extended period of time from areas treated with maximum application rate.	Effects resulting from average application rate are minimal. Some risk from maximum application rate to bees exposed to direct spray.	Effects resulting from average application rate are minimal. Some risks to fish and aquatic-stage amphibians near areas treated with maximum application rate using some of the more toxic formulations not labeled for use in aquatic settings.
Sethoxydim (Source: SERA 2001)				
0.09375 lb/acre (minimum rate) 0.375 lb/acre (maximum rate and recommended rate for the Shawnee NF applications)	No substantial risk at maximum rates.	No substantial risk at maximum rates.	Studies on beetle larvae suggest that rates exceeding maximum rates are relatively non-toxic.	No substantial risk at maximum rates. However, limited toxicological data available. Potential risk to aquatic plants from maximum rates is borderline.
Triclopyr (Source: SERA 2001~~1b3b~~)				
1 lb a. i./acre (average rate) 3.75—8.0 lbs a.i./acre- (recommended rate for Shawnee NF applications) 10 lb a.i./acre (maximum rate)	No substantial risk at average rate. Some risk for mammals exposed via direct spray or consuming sprayed vegetation when applied at maximum rate.	No substantial risk at average rate. Some risk for large bird exposed via direct spray or consuming sprayed vegetation when applied at maximum rate.	Reported to be practically non-toxic to bees.	No substantial risk when triethylamine (TEA) salt formulations are applied at average rate. Some risk to aquatic species when butoxyethyl ester (BEE) formulations are applied at average rate. Substantial risk when BEE formulations applied at maximum rate.
Clopyralid (Source: SERA 2004a)				
0.1 lb a. i./acre (typical rate) 0.5 lb a. i /acre- (recommended rate for Shawnee NF applications) 1.0 lb a. i./acre (maximum rate)	Reported to be relatively non-toxic, with little potential for adverse effects.	Reported to be relatively non-toxic, with little potential for adverse effects. However, based on limited available toxicological data.	Reported to be relatively non-toxic to bees, with little potential for adverse effects. However, based on limited available toxicological data.	Reported to be relatively non-toxic, with little potential for adverse effects. However, aquatic plants are somewhat more sensitive.
Picloram (Source: SERA 2011~~03~~c)				
0.35 lb a. i./acre (typical rate) 1.0 lb a. i./acre (maximum rate and recommended rate for Shawnee NF applications)	Reported to be relatively non-toxic. Increases in liver weight have been observed in some mammals subjected to high rates.	Reported to be relatively non-toxic, with little potential for adverse effects even at higher rates.	Reported to be relatively non-toxic to bees, with little potential for adverse effects similar to effects on mammals and birds. However, this is based on limited available toxicological data.	Reported to be mildly toxic to freshwater fish. However, aquatic plants are somewhat more sensitive. The use of picloram in Forest Service programs is not likely to lead to adverse effects in aquatic species. However, this is based on limited available data.

Note: All rates noted, including "maximum rate", are labeled rates. See other Appendix tables for comparable information.

Appendix C. Herbicide Risk Characterization for Wildlife Species

Clopyralid (SERA 2004a)	
Mammals, Birds, and Terrestrial Invertebrates	No adverse effects are anticipated in terrestrial animals from the use of clopyralid in Forest Service programs at the typical application rate of 0.35 lb a.e./acre. The same holds for the maximum application rate of 0.5 lb a.e./acre, except for large birds or mammals feeding exclusively on contaminated vegetation over a long period of time (i.e., 90 days). The scenarios assume that the vegetation is treated and that the animal stays in the treated area consuming nothing but the contaminated vegetation. Given that most forms of vegetation would likely die or at least be substantially damaged, this exposure scenario is implausible. It is, however, routinely used in Forest Service risk assessments as a very conservative upper estimate of potential exposures and risks. The longer term consumption of vegetation contaminated by drift or the longer term consumption of contaminated water or fish – yield hazard quotients that are far below a level of concern.
Aquatic Organisms	Clopyralid appears to have a very low potential to cause any adverse effects in any aquatic species.
Soil Microorganisms	Maximum concentration of clopyralid in soil will be in the range of 0.2 to 0.25 mg clopyralid/kg soil at an application rate of 1 lb a.e./acre. At the maximum application rate of 0.5 lb a.e./acre, the estimated maximum soil concentrations would be in the range of 0.1 to 0.125 mg clopyralid/kg soil. These projected maximum concentrations in soil are far below potentially toxic levels.
Glyphosate (SERA 2011a)	
Mammals, Birds, Terrestrial-phase Amphibians and Terrestrial Invertebrates	Effects to birds, mammals, and invertebrates are minimal. Based on the typical application rate of 2 lbs a.e./acre, none of the hazard quotients for acute or chronic scenarios reach a level of concern even at the upper ranges of exposure. For the application rate of 7 lbs a.e./acre, there is some level of concern with direct spray of honey bees, for large mammals consuming contaminated vegetation, and small birds consuming contaminated insects. These concerns are based on conservative dosing studies and environmental conditions that are not likely to occur in the field. There is relatively little information available on the toxicity of glyphosate to terrestrial-phase amphibians. Of the four studies noted in the 2011 SERA risk assessment, only one reported significant mortality from direct spray with terrestrial Glyphosate. Consequently, exposure to direct spray is a scenario of potential concern.
Aquatic Organisms	Some formulations of glyphosate are much more acutely toxic to fish, aquatic-phase amphibians and aquatic invertebrates than technical grade glyphosate or other formulations of glyphosate. This difference in acute toxicity among formulations appears to be due largely to the use of surfactants that are toxic to fish, amphibians and invertebrates. One study by Howe et al (2004) reported changes in thyroid hormone function as well as increase in intersex gonads in aquatic-phase amphibians after long term (42 days) exposure to Glyphosate with the surfactant (e.g. Roundup).
Soil Microorganisms	Transient decreases in the populations of soil fungi and bacteria may occur in the field after the application of glyphosate at application rates that are substantially less than those used in Forest Service programs. Several field studies have noted an increase rather than decrease in soil microorganisms or microbial activity, including populations of fungal plant pathogens, in soil after glyphosate exposures. While the mechanism of this apparent enhancement is unclear, it is plausible that glyphosate treatment resulted in an increase in the population of microorganisms in soil because glyphosate was used as a carbon source and/or treatment with glyphosate resulted in increased nutrients for microorganisms in the soil secondary to damage to plants.
Sethoxydim (SERA 2001)	
Mammals, Birds, and Terrestrial Invertebrates	No adverse effects can be anticipated in terrestrial animals from the use of this compound in Forest Service programs.
Aquatic Organisms	There is no indication that fish, aquatic invertebrates, or aquatic plants are likely to be exposed to concentrations of sethoxydim that will result in toxic effects.
Soil Microorganisms	At sethoxydim concentrations <50 ppm, negligible response was noted in microbial populations. At higher concentrations (1000 ppm), soil actinomycetes and bacteria populations were stimulated, but fungal populations changed little.
Triclopyr (SERA 2011b)	
Mammals, Birds, Terrestrial Amphibians and Invertebrates	Contaminated vegetation is the primary concern in the use of triclopyr and that high application rates will exceed the level of concern for both birds and mammals in longer term exposure scenarios. For terrestrial mammals, the central estimates of hazard quotients do not exceed the level of concern for any exposure scenarios. Tryiclopyr is slightly to practically non-toxic to birds and practically non-toxic to bees (http://npic.orst.edu/factsheets/triclogen.pdf). The toxicity of triclopyr or TCP to reptiles or terrestrial-phase amphibians is not addressed in the available literature.
Aquatic Organisms	At an application rate of 1 lb/acre, acute and chronic risks to aquatic animals, fish or invertebrates, as

	well as risk to aquatic plants are low with use of the salt form of triclopyr. At the highest application considered in this risk assessment, 10 lbs a.e./acre, the risks to aquatic animals remain substantially below a level of concern. The ester form of triclopyr is projected to be somewhat more hazardous when used near bodies of water where runoff to open water may occur. Based on the limited data available on toxicity to aquatic-phase amphibians, amphibians appear to be less sensitive than fish by a factor of about 4.
Soil Microorganisms	The potential for substantial effects on soil microorganisms appears to be low. An application rate of 1 lb/acre is estimate to result in longer term soil concentrations that are well below 0.1 ppm – i.e., in the range of about 0.02 to 0.05 ppm – and peak concentrations in the range of about 0.2 ppm. Thus, if the laboratory studies are used to characterize risk, transient inhibition in the growth of some bacteria or fungi might be expected. This could result in a shift in the population structure of microbial soil communities but substantial impacts on soil – i.e., gross changes in capacity of soil to support vegetation – do not seem plausible. This is consistent with the field experience in the use of triclopyr to manage vegetation.
Picloram (SERA 20110~~3c~~)	
Mammals, Birds, and Terrestrial Invertebrates	Even at a high dosage levels in Forest Service projects, effects on these species are minimal. There is concern for the effects of hexachlorobenzene one of the contaminant chemicals in commercial formulations. Hexachlorobenzene is considered as a mild carcinogen bu US EPA and there is concern for handlers and applicators.
Aquatic Organisms	Fish are moderately sensitive to this chemical at moderate and high use rates. Other aquatic species are minimally affected.
Soil Microorganisms	Soil microorganisms appear to be reduced at moderate levels of chemical application. However this is no evidence that these reductions would have any adverse effedts on soil productivity.

Appendix D. Mammalian Toxicity Data

Herbicide Formulation	Acute Toxicity						Chronic Toxicity		
	Oral LD_{50} (rat)	Dermal LD_{50} (rabbit)	4 hour inhalation LC_{50} (rat)	Skin Irritation (rabbit)	Skin Sensitization (guinea pig)	Eye Irritation (rabbit)	24-Month Dietary NOEL (mouse)	24-Month Dietary NOEL (rat)	12-Month Dietary NOEL (dog)
	mg/kg BW		mg/L				mg/kg BW/day		
Glyphosate									
Glyphosate acid	5600	>5000	NA	None	No	Slight	4500	400	500
Blyphosate iso-propylamine salt	>5000	>5000	NA	None	No	Slight	Chronic toxicity data available only for technical glyphosate acid		
Glyphosate trimethylsulfonium salt	748	>200	>5.18 (usnpec.)	Mild	Mild	Mild			
ROUNDUP	>5000	>5000	3.2	None	No	Moderate			
RODEO	>5000	>5000	1.3	None	No	None			
LANDMASTER Glyphosate + 2,4-D	3860	6366	NA	Moderate	NA	Severe			
Sethoxydim									
Sethoxydim	2676	>5000 (rat)	6.1	None	No	None	18	NA	8.86
POAST	4.1	>5000 (rat)	>4.6	Moderate	No	Moderate	Chronic toxicity data available only for technical sethoxidim		
POAST PLUS	>2200	>2000 (rat)	>7.6	Slight	No	Slight			
Triclopyr									
Triclopyr acid	713	>2000	NA	None	Positive	Mild	5.3 (22 mo)	3	NA
GARLON 3A	2574	>5000	>2.6 (unspec.)	NA	NA	Severe	Chronic toxicity data available only for technical triclopyr acid		
GARLON 4	1581	>2000	>5.2 (unspec.)	Moderate	Positive	Slight			
Clopyralid									
Clopyralid acid	>5000	>2000	>1.3 (unspec.)	Very Slight	No	Severe	500 (18 mo)	50 (rat)	100
STINGER	>5000	NA	NA	NA	NA	NA	Chronic toxicity data available only for technical clopyralid acid		
Picloram									
Picloram acid	>3436	>2000	>1.63 (unspec.)	Very Slight	YES	Moderate	500 (24 mo)	20 (rat)	35 (dog)
TORDON	>8200	>4000	NA	NA	NA	NA	Chronic toxicity data available only for technical picloram acid		

Source: SERA 2001, 2003a, 2011b, 2011c, 2004)
NA = Not Available

Appendix E. Toxicity Data for Other Types of Wildlife, Herbicides Potentially Used as Part of Proposed Action

Herbicide Formulation	**Avian Receptors**				**Terrestrial Invertebrates**		**Aquatic Receptors**		
(Technical product unless specific formulation noted)	Bobwhite Quail		Mallard Duck		Earth-worm	Honeybee	Daphnia	Bluegill	Rainbow Trout
	Oral LD_{50}	8-day dietary LC_{50}	Oral LD_{50}	8-day dietary LC_{50}	LC_{50}	Topical LD_{50}	48-hour LC_{50} or EC_{50}	96-hour LC_{50}	96-hour LC_{50}
	mg/kg BW	ppm (in food)	mg/kg BW	ppm (in food)	ppm (in soil)	ug/bee	mg/L (in water)		
Glyphosate									
Glyphosate acid	>4640	>4640		4640		>100	780	120	86
Glyphosate trimethylsulfo-nium salt		>5000	950	>5000		>62.1	71	3500	1800
ROUNDUP					>5000	>100	5.3	5.8	8.2
RODEO							930	>1000	>1000
Sethoxydim									
Sethoxydim		>5620	>2510	>5620				100	32
Triclopyr									
Triclopyr acid		2934	1698	>5620		>100	133	148	117
Triclopyr butoxyethyl ester		5401		>5401		>100	1.7	0.36	0.65
Triclopyr triethylamine salt		>10000	3176	>10000		>100	775	891	613
Clopyralid									
Clopyralid acid		>4640	1465	>4640	1000	>0.1	232	125	104
Fosamine ammonium salt	>5000	>5620	>5000	>5620		Non-toxic	1524	590	330
Picloram									
Picloram salt	>2000	>10000	>2510	>10000		>0.1	68.3	14.5-19.4	5.5
TORDON	>2000	>5000	>2000	>5000			>100	10-100	10-100